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ARMSTRONG LABORATORY

FEASIBILITY STUDY FOR A PERSONAL-COMPUTER BASED HEAD-SPINE MODEL

John B. Bomer
David J. Pancratz
Linda J. Rogers

BIODYNAMIC RESEARCH CORPORATION
9901 I.H. 10 WEST, SUITE 1000
SAN ANTONIO TX 78230

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FOR THE DIRECTOR

Thomas J. Moore

THOMAS J. MOORE, Chief
Biodynamics and Biocommunications Division
Crew Systems Directorate
Armstrong Laboratory

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John B. Bomar, Jr., Ph.D.
David J. Pancratz, MSME
Linda J. Rogers, MSCS

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Biodynamic Research Corporation
9901 IH 10 West, Suite 1000
San Antonio, TX 78230

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13. ABSTRACT *(Maximum 200 words)*
Biodynamic Research Corporation (BRC) of San Antonio, TX, completed an SBIR Phase I project to port the Air Force's Head-Spine Model (HSM) to a PC-DOS environment and provide a recommended roadmap for the future of the HSM. The impetus for this project was the Air Force's desire to have a software tool capable of modeling the internal forces and motions of the human head and spine during impulsive acceleration events. The program, originally designed to run on a mainframe computer, had been ported to a Unix workstation. BRC was able to successfully port the code to an MS-DOS compatible PC computer. The DOS and Unix versions code transfer was successful, BRC discovered several "problems" with the HSM which made creating a general purpose HSM code impossible. The cost and effort required to understand the current version, debug coding and algorithm errors, and document the code is far greater than simply extracting the useful data and starting over. Therefore, BRC recommended that the HSM be rewritten for the PC environment and that the development program be conducted under a rigorous protocol designed to ensure documentation of the model's domain of applicability.

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The research team wishes to express their gratitude for the cooperation, support, and guidance of the Air Force Technical Project Manager Dr. Louise Obergefell of the Armstrong Laboratory.

The assistance provided by Mr. Bob Gallaway and Ms. Annette Rizer both of SRL, Incorporated was very helpful. Ms. Rizer's help in getting the archived HSM materials organized and shipped to BRC was essential in making early progress on the program. Mr. Gallaway's suggestions relating to user interface improvements were incorporated in the recommendations for future improvements to the HSM.

Finally, the research team gives a very special thank you to the support staff at BRC. Without the efforts and dedication of Celina Canales and Anne Hofmeister in operations support, this research program could not have been reported effectively. Appreciation is also due to Dr. James Raddin and Eric Weiss for technical support, John Martini for illustration support, and Patricia Perret for information services support. And last, but not least a special thanks is given to Sue for her support during this research program.

SECTION 1

SUMMARY

1.0 Summary.

Biodynamic Research Corporation (BRC) of San Antonio, TX, completed an SBIR Phase I project to port the Air Force's Head-Spine Model (HSM) to a PC-DOS environment and provide a recommended roadmap for the future of the HSM. The impetus for this project was the Air Force's desire to have a software tool capable of modeling the internal forces and motions of the human head and spine during impulsive acceleration events, particularly aircraft ejections. Although models exist to predict the gross motion of a human under acceleration loading such as the Air Force Articulated Total Body (ATB) model, Dynaman, and MADYMO, the Head-Spine Model (HSM) is the only tool able to provide estimates of internal forces. For this reason, the HSM could be valuable to the Air Force and other scientists for simulating acceleration environments.

The HSM was presented to BRC as archived FORTRAN files that had been unused for nearly 8 years; none of the scientists originally involved in the development of the HSM were available for consultation. The program, originally designed to run on a Concurrent mainframe computer, had been ported to a Silicon Graphics Incorporated (SGI) Unix workstation. BRC was able to successfully compile and operate the model on an SGI workstation and port the code to an MS-DOS compatible PC computer. The DOS and Unix versions of the model produced essentially the same output for three different simulations.

Although the code transfer was successful, BRC discovered several "problems" with the Head-Spine Model. For one, the code was written in such a way that it required both an input file of material and geometry data for each simulation and a FORTRAN source file or set of source files that had to be recompiled for each simulation. This handicap made it difficult to change the characteristics of a simulation using the HSM. The model was also coded so that it was difficult to understand, debug, and modify. There are several areas in the model code that BRC suspects are incorrectly implemented, however, there is no way to confirm this because of the lack of comments and documentation. An attempt was made to restructure some of the FORTRAN model code in modern structured Fortran 77 code.

To assist in understanding the input and output data for an HSM simulation, BRC developed a custom software program that reads the input file and displays it for modification, runs the HSM model, and reads the output data and allows it to be graphed and printed. Unfortunately, as noted earlier, the HSM still requires recompilation.

It is BRC's belief that the material and geometry data of the HSM model, as well as some of the model algorithms and logic, can best be used by recreating the model in an object-oriented software language such as C++ or Fortran 90. The cost and effort required to understand the current version, debug coding and algorithm errors, and document the code is far greater than simply extracting the useful data and starting over. A roadmap for developing the PC-based HSM is presented at the end of this report. Figure 1-1 summarizes the Phase I Results.

Figure 1-1 Summary of Results

Porting the HSM to a PC
•Compiled and is executable on a PC and Silicon Graphics. •Nearly identical results on a PC and SGI. •Three simulations conducted.
HSM Improvements
•Graphical user interface created for changing input file, running the model, and displaying outputs. •Structured Fortran techniques incorporated into code. •Apparent errors found in the original code.
Critique of the Model
•Difficult to validate because of the number of degrees of freedom and many parameters. •Is the only model that provides internal force and motion computations.
Recommendations
•The Head-Spine Model be re-coded with a modern, object-oriented approach. •Use existing material and geometry data from the original HSM. •Validate the model for certain input forces and accelerations. •Commercialize the use of the model.

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SECTION 2

INTRODUCTION

2.0 Introduction.

This final report concludes an effort by Biodynamic Research Corporation (BRC) of San Antonio, TX, to port the Air Force Head-Spine Model to a PC-DOS computer and conduct a feasibility study for making the HSM a useful desktop tool. The effort was conducted under Contract F41624-95-C-6003 through the Armstrong Laboratory and is entitled "Feasibility Study for a Personal-Computer Based Head-Spine Model."

This effort emanates from the Air Force's desire to develop a mathematical model of the internal forces and motions that occur within the human head and spine during impulsive acceleration events and aircraft ejections in particular. Existing tools such as the Articulated Total Body (ATB) model, Dynaman, and MADYMO are able to simulate a human's gross motion to forces and accelerations, but are either unable or invalidated for computing the internal dynamic and kinematic quantities. These internal forces and stresses can be used as predictors for injury. A validated HSM would be a useful tool for Air Force and commercial researchers and scientists in a variety of fields.

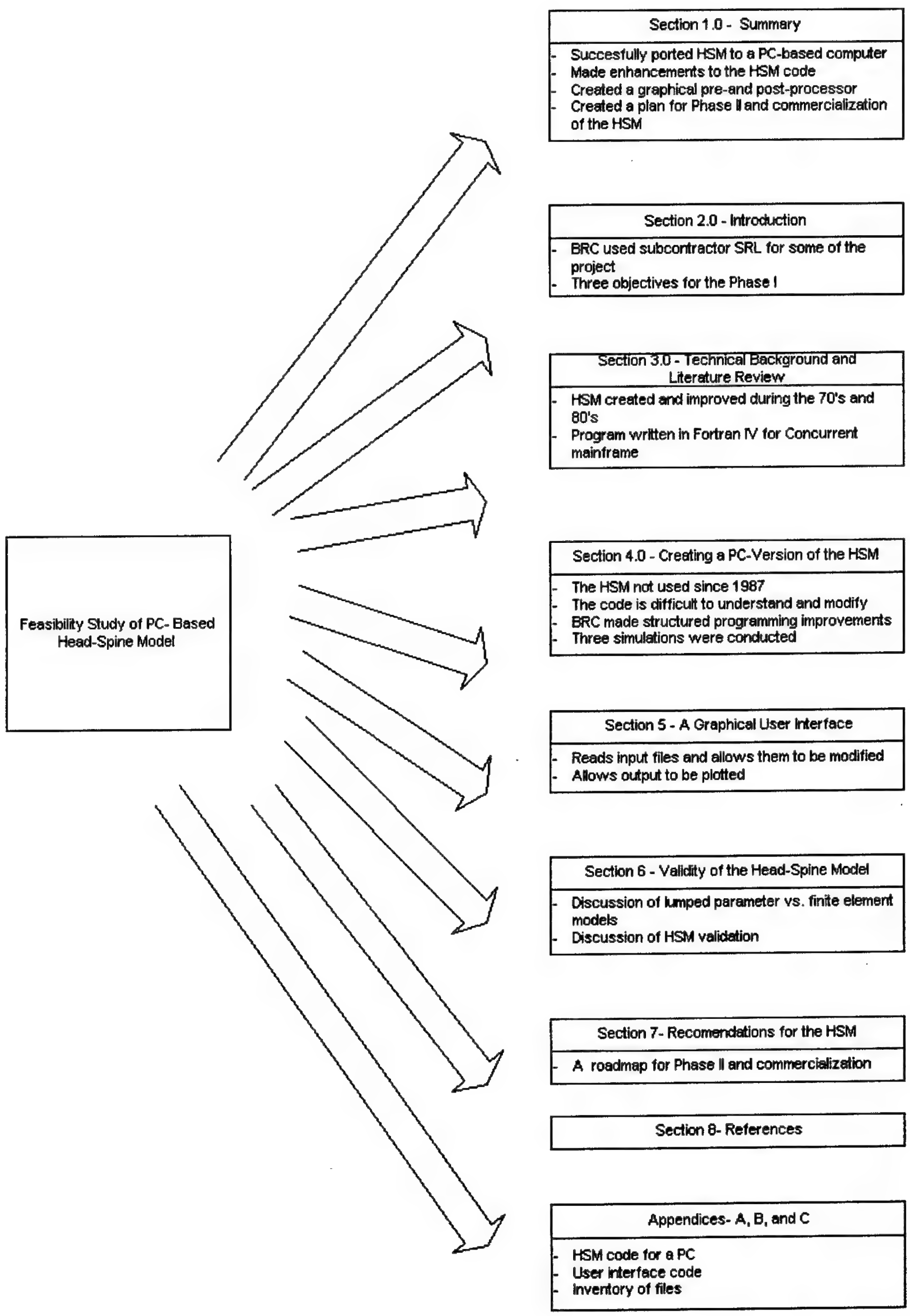
The specific objectives of the Phase I effort are listed below:

- To port the HSM from a Silicon Graphics Unix computer to a desktop PC-compatible computer.
- To conduct a feasibility analysis of improving the software implementation of the model, adding a user-interface, and documenting the model.
- To evaluate the merits and limitations of the model, suggest ways to enhance the realism of the model or decrease it's complexity, and identify a protocol for validating the model operation under certain conditions.

BRC performed a majority of the work for this contract. Systems Research Laboratory (SRL) of San Antonio, TX, assisted with some of the analysis to identify an ideal user interface for the model.

This final report documents and summarizes the work generally according to the objectives outlined above. The layout of the report is summarized in Figure 2-1.

Figure 2-1 The HSM Final Report



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SECTION 3

TECHNICAL BACKGROUND AND LITERATURE REVIEW

3.0 Technical Background and Literature Review.

The Air Force Head-Spine Model (HSM) was initially developed for the purpose of modeling pilot ejections from aircraft. In 1973-5, a three-dimensional model of the human spine and head was created at the University of Illinois, sponsored by the Air Force Aerospace Medical Research Laboratory.[1] The model consists of rigid bodies, which represent skeletal segments, and deformable elements, which represent ligaments, cartilaginous joints, viscera, and connective tissues. The model can be separated into sub-models to study the response of different body segments to accelerations and loads. The original HSM is theoretically sufficiently general to be applicable to other acceleration environments. A technique for modeling other aspects of the environment, such as seat geometry and restraint harness, are also considered in the HSM. Output of the model includes the forces and moments acting on the elements and the kinematics of the model elements.

The HSM was refined in 1976-7 during a second Air Force project.[2] During this project, four different versions of the model were created ranging from 32 to 252 degrees of freedom. The researchers also attempted to refine and validate the model using two methods -- by comparing the model frequency response to the experimentally determined frequency response of humans to vertical excitation and by creating head-spine models for other primates and comparing the model output to experimental data. The work with the primate model also provided a methodology for scaling dynamic response and injury data between the primates and humans. Finally, a spinal injury criteria were developed that use the computed stress in vertebral bodies to predict the likelihood of vertebral body failure.

A database of head and cervical spine geometry and stiffness data was collected in a third project from 1978-80.[3] The geometry of the vertebrae and points of attachment of muscles, discs, and ligaments were obtained. Stiffness data were obtained or estimated from the literature. Inertia values were developed by approximating the geometry of the vertebrae and applying a uniform density. Simulations with the model were in relatively good agreement with experimental data for the first 150 milliseconds of response. After this time, the model output showed significant discrepancies which the authors attributed to poor modeling of the major muscles. Although this project focused on the head and cervical spine, it used portions of code from the entire HSM model.

One final revision to the Head-Spine Model was an effort from 1980-4.[4] During this project, a model of the diaphragm was incorporated into the HSM that better represented the vertical load path through the viscera, abdomen, and rib-cage region. Additional work was done to create a proposed injury criterion for the cervical spine. Simulations with the head and cervical spine model in the fore-aft and side-to-side directions showed a good agreement to experimental data, which led the authors to believe the model was a viable tool for prediction of head-cervical spine kinematics in three dimensions.

Figure 3-1 summarizes our literature search efforts and results.

Figure 3-1 **Literature Search Summary**

Literature Search Topics	
	Subject Areas: •Head/neck/spine modeling. •Injury modeling and criteria. •Dynamic response of the head/neck/spine. •Air Force Head-Spine Model. Authors: •Abe Privitzer •Jeff Settecerri •T. Belytschko
Briefs for Select Related Literature	
1.	"A Model for Analytic Investigation of Three-Dimensional Head-Spine Dynamics," [Ref 1]. Development of the original Head-Spine Model and techniques for modeling environment, restraints, and seats.
2.	"Refinement and Validation of a Three-Dimensional Head-Spine Model," [Ref 2]. Refinement and partial validation of the Head-Spine Model.
3.	"A Dynamic Model of the Cervical Spine and Head," [Ref 3]. Discussion of geometry and material data for the HSM and simulations with the cervical spine and head portion of the model.
4.	"Head-Spine Structure Modeling: Enhancements to Secondary Loading Path Model and Validation of Head-Cervical Spine Model," [Ref 4] Incorporation of abdominal load path and spinal injury criteria into the model.
5.	"A Biomechanical Model of the Human Spinal System," [Ref 6]. Describes a finite-element model of the spinal column, ligaments, muscles, rib-cage, abdomen, and part of the pelvis.
6.	"Tolerance of the Human Cervical Spine to High Acceleration: A Modeling Approach," [Ref 7]. Development of and simulations with a sagittal plane model of the cervical spine.
7.	"An Analytical Model of Intervertebral Disc Mechanics," [Ref 8]. A model of the intervertebral disc which predicts loads within the annulus.
8.	"Cervical Spine Analysis for Ejection Injury Prediction," [Ref 9]. Sagittal plane model for the cervical spine and skull that includes muscles, ligaments, and intervertebral joints.

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SECTION 4

PORTING THE CODE TO A PC

4.0 Creating a PC Version of the Head-Spine Model.

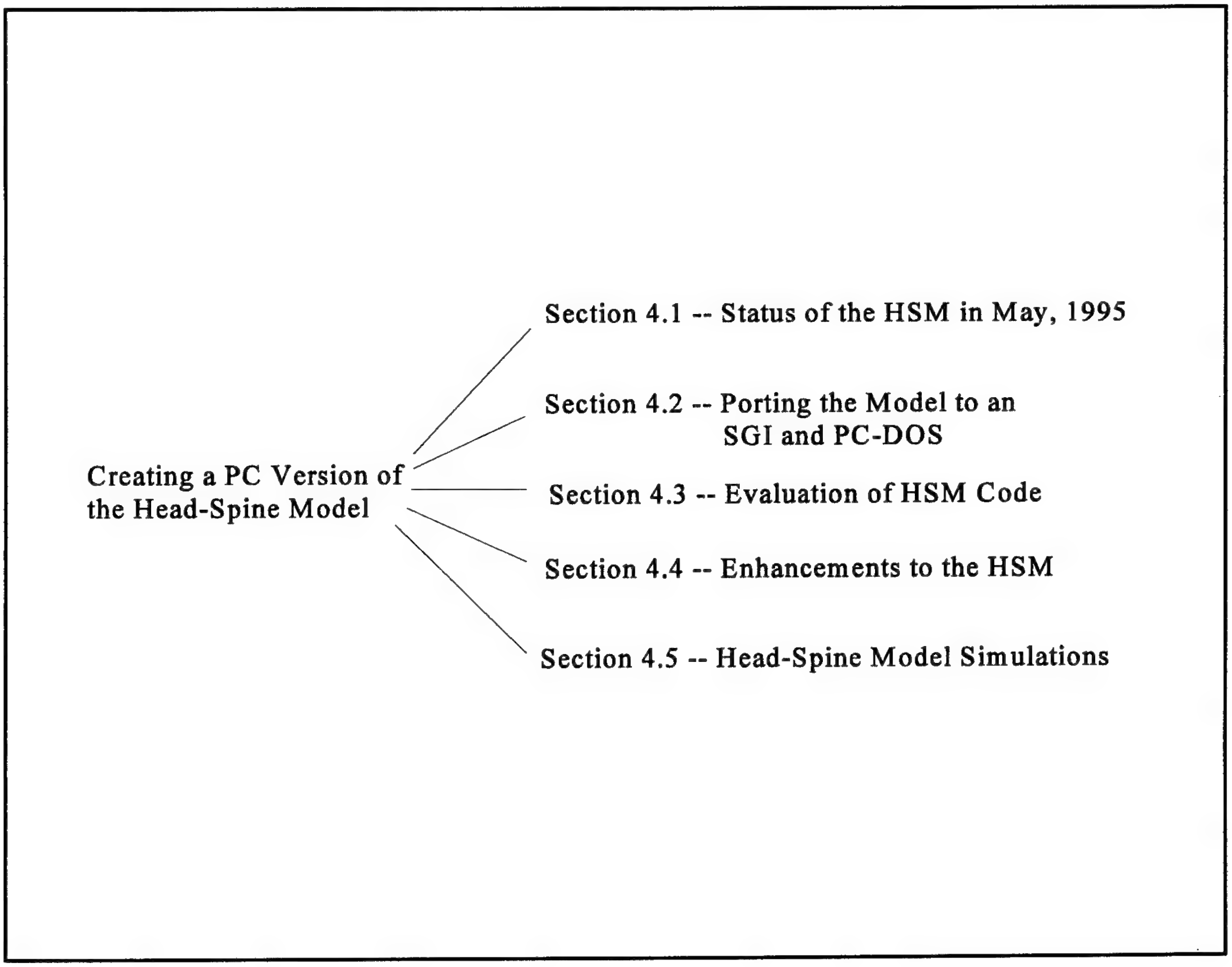
The Head-Spine Model was recompiled on a PC-DOS computer and modified so that it could perform three simulations with identical outputs to the original Unix version of the model. When first presented to BRC, the HSM model had been virtually unused since 1987. The materials that BRC obtained and the status of the HSM model before this project are described in detail in Section 4.1.

BRC had little difficulty in porting the HSM to both a PC-DOS computer and an SGI Indigo computer running Unix. The various minor problems encountered are detailed in Section 4.2. An audit was conducted of the output produced by the new executables and the archived output; the PC-DOS version of the model was found, with minor differences, to compute the same results as the archived executables.

Although porting the code proved fairly easy, the HSM code itself was difficult to understand, debug, and modify. Section 4.3 discusses some of the problems encountered, which were a combination of FORTRAN IV constraints and poor programming techniques. Our efforts to improve the coding of the model are described in Section 4.4. Several elements of structured programming were incorporated into the code, including DO...END DO statements, BLOCK IF structures, and better formatting.

Finally, Section 4.5 describes the simulations that BRC was able to conduct with the model. We were able to successfully execute only three simulations, two of which were very simple. It was discovered that HSM simulations required both a special input file of material and model geometry data, as well as a unique subroutine or set of subroutines that had to be compiled with the remainder of the model. Although other input files were found in the archived code, BRC was unable to make these simulations execute properly. Figure 4-1 presents an overview of the contents of Section 4.

Figure 4-1 Creating a PC Version of the HSM



4.1 Status of the Model in May, 1995.

Before the start of this Phase I SBIR, the Head-Spine Model software and documentation had been virtually unused since 1987. In 1987, a document titled "Directions/Overview for Running the Head Spine Model" was created at WPAFB that summarized the status of the model. This document, along with the user's manual for the model and various technical reports, provided a foundation for BRC to trace the model history and become familiar with the model.

BRC was presented with the documentation and archived code in June of 1995. All of the materials received from the Air Force have been recorded and an inventory of files is attached in Appendix C and a summary of other materials is shown in Figure 4-2. The materials include program listings, technical reports, sample runs, and magnetic media. The files on the magnetic media included the most recent version (1987) of the HSM software for use on a Silicon Graphics workstation and two archived directories of material.

BRC conducted a line-by-line comparison of the magnetic media files and the printed code that was reported to be the "most current version of the HSM" to ensure that the proper version of the software was analyzed. A few minor discrepancies were discovered; however, the code audit confirmed that BRC indeed had the source code corresponding to the "most current version of the HSM."

The code provided to BRC included an executable of the model for SGI Unix. It was possible to execute this file without modification for the "hyb2.inp" input file, which apparently corresponded to a Hybrid II Anthropomorphic Mannikin Head-Neck pendulum test. Results of this simulation are discussed in Section 4.4.

Figure 4-2 Inventory List

Inventory Items
•Program listing 2/17/81 •Plotting program source 11/9/77 •Sample run 8/6/87 head & cervical spine, ½ spine input accel. Profile •Sample run 8/19/87 isolated ligamentous spine model 14 G, 100 ms •Sample run 8/6/87 simplified based on SSM deformations •Sample run 9/19/83 Sikorsky IV 003 w/ injury criteria •Sample run 12/7/81 baboon model 1B •Sample run 11/18/80 bird strike simulation •Sample run GHSM rectangular arc profile simulation •Energy absorbing seat design •Sample run 5/12/83 axial load uniform pressure distribution •Fastplot listing and instructions by M. Hoffman •"Head Spine Model Northwestern Version 1978 Input File Description" •"Head Spine Model Input File Description 1979" •"Dynamic Distribution of Stress and Injury Likelihood in the Spine", by M. Hoffman, 1983 (2 copies) •Brown binder -- compilation of materials •HSM user manual by L. Schwer and G. Belytschko, modified by M. Hoffman 4/11/77 (2 copies) •Color coding for HSM, user guide for output, by M. Hoffman 4/11/77 (2 copies) •Tech paper AF binder, "Head Spine Structure Modeling: July 1985 Enhancement to Secondary ...", by T. Belyschko, M. Rencis, and J. Williams •HSM user guide May 1985 by SRL •Sample run 3/12/82, SAP 4 head injury model, 1500 N vertical load •HSM source code listing 10/15/84 •Fastplot source code file and variations 11/83 •HSM source code listing 8/24/84 and miscellaneous plots •HSM source code for subroutines: Freefds, Injcri, Spinif, Sliders, Baboon, Splmfit •Sample run CR24B 1984 Pre-Crest simulations •Magnetic tape of most current HSM files and two archived directories of older HSM files.

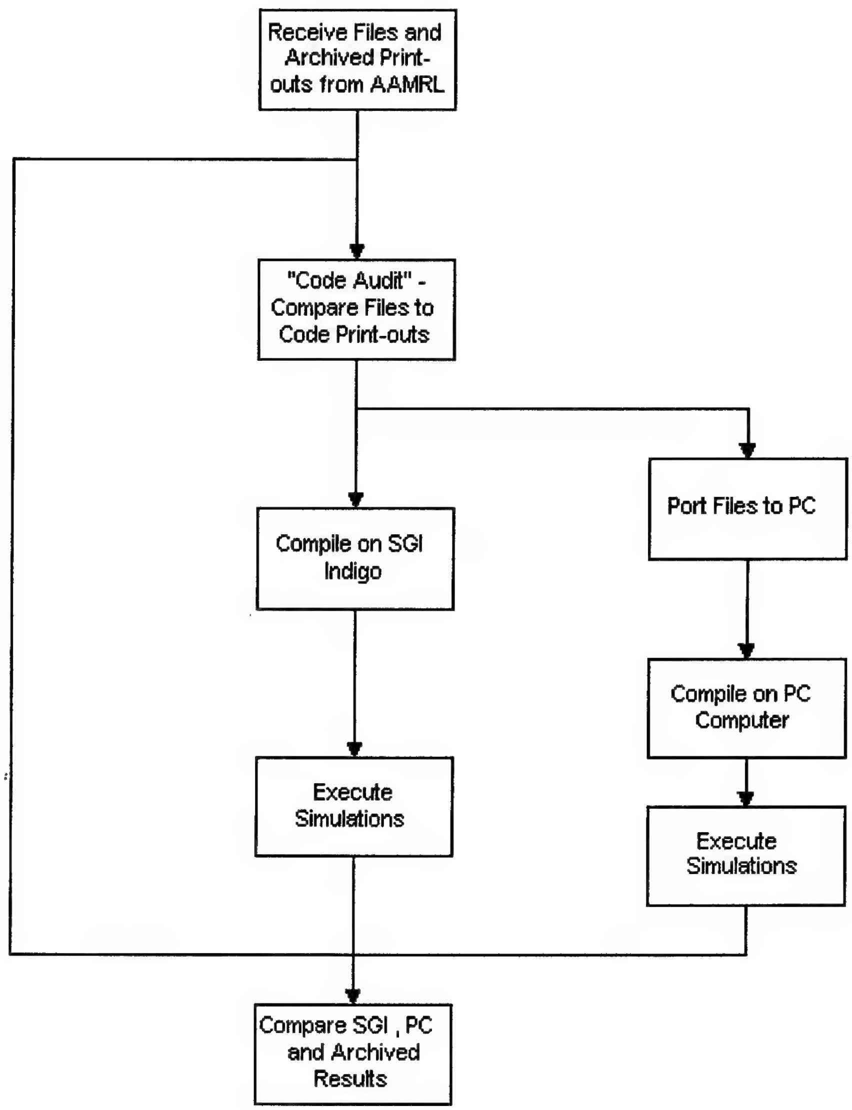
4.2 Porting the HSM Code to an SGI Indigo and PC-DOS Computer.

An executable of the HSM code was created for an SGI Indigo workstation and a PC-DOS computer. A similar procedure was followed on both platforms to create the executables. First, subroutines that performed no function or were involved in printing or plotting to an actual device were removed. This eliminated many "unsatisfied external references" errors issued by the compilers. Subroutines were then added and debugged until there were no unsatisfied externals. Most "bugs" were comprised of illegal characters and minor syntax errors which were easily corrected. The final compilation was successful, but produced "run-time errors" which were systematically investigated and eliminated until a program was produced which would execute with the input file "hyb2.inp." The output file from the PC was compared to an existing output file for the "hyb2.inp" which ran on the Silicon Graphics computer via an executable which was provided in the software archives.

The PC version of the model was compiled on an IBM compatible PC running Microsoft Windows 3.1 using Microsoft FORTRAN Powerstation Professional Development System v 1.0. The SGI version of the model was compiled on a Silicon Graphics XS24 Indigo running IRIX Unix v 5.3 and a FORTRAN 77 v 4.0.2 compiler.

The process of porting the HSM code to a PC and verifying proper execution is summarized in Figure 4-3. The modifications made to the code at this point of the project were only those necessary to make the model execute; a discussion of the general condition of the code is presented in Section 4.3. The final code for the PC-version of the Fortran code is listed in Appendix A.

Figure 4-3 Process of Porting HSM Code



4.3 Evaluation of HSM Code.

The HSM code was originally written in FORTRAN IV and is, in general, difficult to understand, debug, and maintain. When presented to BRC, the HSM code had many problems, some typical of FORTRAN code, such as:

- The use of GOTO statements, which obfuscate the flow of the program. There were many logical loops and branch statements that relied on GOTO's to redirect program flow.
- A lack of substantive comments. There were virtually no useful, descriptive comments in the code.
- A confusing use of COMMON blocks, which sometimes used different variable names in different subroutines.
- Overwriting of memory allocated for an array. While this technique can be used to minimize the use of memory, it appears that data was being overwritten outside of the array bounds, which may have caused erroneous results.
- Numerous calls to blank "do-nothing" subroutines, or subroutines that involved plotting results on antiquated devices.
- Subroutines that contained a significant amount of code, but were not called because of program redirection before the subroutine calls.
- Subroutines that were passed variables that were never used.
- A lack of indenting and spacing in the code, which would have allowed a more intuitive understanding of program flow.

Some of the HSM problems were simply due to the nature of early FORTRAN. For example, constraints in formatting and a lack of structured programming statements resulted in some of the problems above. The lack of comments, questionable use of array memory, and substantial numbers of extraneous variables and subroutines were indicative of the programming style. Some examples of poor coding techniques are displayed in Figure 4-4.

The nature of the HSM code made it very difficult to logically trace program flow. An effort was made to update the code, both to improve the readability and better understand the logic flow. These efforts are described in Section 4.4.

Figure 4-4 Examples of HSM Code

Example of Lack of Formatting

```
      STRS(IEE)=.5D0*UKE
      IF (NSLIDP.EQ.0) GO TO 6
      CALL SLIDER (NSLIDP,FORCD,FINT,SMASS,A1,X1,TIME,BETA,NCP,NASN,INME
     1SH,DICOSP,ALPHA,UP,UP2,NPNO,SEATK,UPOLD,SEATWK,SEATEX,V,UP1,VD
     2AMP,DELT)
    6CALL UPDATE ( NPRI,NDGREE,DELT,X1,XO,V,A1,EULCO(1,1,1),BETA )
      CALL FRCIN (NUMEL,NUMNP,NDGREE,XC,YC,ZC,IX,E,X1,FINT,STRS,STRAIN,S
     1TRESS,IPT,INDEX,EULCO,SMASS,DICOS,NPRI,AL,IEIGEN,YIPT,ZIPT,XLEN,TH
     2CK,INMESH)
      WRITE (6,902)
```

Example of Confusing Logic

```
   19 I=I+1
      IF (I.GT.NEQ) GO TO 21
      IF (SMASS(I).EQ.0.) GO TO 20
      X1(I)=XO(I)+V(I)*DELT+C1*AO(I)
      GO TO 19
   20 I=I+5
      GO TO 19
   21 CONTINUE
```

No Comments

```
      DO 90 I=1,NB
      FP=DABS(PE(I))/PY(I)
      FMZ=DABS(BMZE(I))/BMZY(I)
      FTEMP=FP+FMZ
      IF(FTEMP.LT.F1(I)) GO TO 81
      F1(I)=FTEMP
      FA(I)=F1(I)
      PF1(I)=PE(I)
      BMF1(I)=BMZE(I)
      TF1(I)=TYME
   81 FMY=0.D0
      IF(ISYM.EQ.0) GO TO 90
      FMY=DABS(BMYE(I))/BMYY(I)
      FTEMP=FP+FMY
      IF(FTEMP.LT.F2(I)) GO TO 82
      F2(I)=FTEMP
      PF2(I)=PE(I)
      BMF2(I)=BMYE(I)
      TF2(I)=TYME
   82 FTEMP=FP+DMAX1(FMY,FMZ)
      IF(FTEMP.LT.F(I)) GO TO 90
      F(I)=FTEMP
      FA(I)=F(I)
      PF(I)=PE(I)
      BMF(I)=BMYE(I)
      IF(FMZ.GE.FMY) BMF(I)=BMZE(I)
      TF(I)=TYME
   90 CONTINUE
```

4.4 Head-Spine Model Enhancements.

BRC improved the structure of the model FORTRAN code and created an intuitive user interface for modifying the HSM input files. Some aspects of structured FORTRAN were incorporated into the Head-Spine Model code to help better understand the flow of the program.

As was noted in Section 4.3, the HSM code was presented in a way that made it difficult to understand and modify. BRC spent a significant amount of time improving the HSM code so as to better understand the flow and enhance the readability for the future. One of the first improvements was to eliminate calls to blank subroutines and subroutines involved in plotting output. Presumably, the blank subroutines represented areas of expansion for the model that were never undertaken. Numerous variables that were passed into subroutines but not used were also removed. BRC took advantage of compiler INCLUDE statements to replace many of the COMMON blocks which, because of their length, distracted the reader from the function of the subroutines.

BRC also implemented some features of structured programming. Branch IF statements that relied on GOTO's for redirection were changed to BLOCK IF statements. In some cases this proved impossible without rewriting the entire subroutine. DO...END DO statements were used to replace DO...CONTINUE statements. More liberal use of indenting and spacing of code was included to make the program more readable. The use of line numbers was eliminated whenever possible.

No attempt was made to correct several arrays that were suspected of being accessed improperly. Making these changes would have prevented us from understanding the effect of other modifications on the code, since the output of the program would then be different. Several calls to subroutines that were never used because of logic preceding the call to the subroutine were left in place. It is suspected that these subroutines might be required for other simulations, although none of the simulations BRC made operational required them.

Examples of typical HSM code segments before and after the Phase I project are shown in Figure 4-5.

Figure 4-5 Examples of Modified Code

Old Segment of Code

```
19 I=I+1
  IF (I.GT.NEQ) GO TO 21
  IF (SMASS(I).EQ.0.) GO TO 20
  X1(I)=XO(I)+V(I)*DELT+C1*AO(I)
  GO TO 19
20 I=I+5
  GO TO 19
21 CONTINUE
```

New Segment of Code

```
19 I=I+1
     IF (I.LE.NEQ) THEN
       IF (SMASS(I).NE.0.) THEN
         X1(I)=XO(I)+V(I)*DELT+C1*AO(I)
         GO TO 19
       END IF
       I=I+5
       GO TO 19
     END IF
```

Old Segment of Code

```
      DO 9 JE=1,NUMEL
        ISEC=IX(11,JE)
      IF(NOPT.EQ.6) IADD=5
        IF (NOPT.NE.2) GO TO 5
        I1=1
        IF (ISEC.NE.0) I1=IPT(ISEC)
        IADD=41+6*I1
        IF (KONTRL(5).GT.0) IADD=41+8*I1
    5   INDEX(JE+1)=INDEX(JE)+IADD
        IND=INDEX(JE)-1
        IF (NOPT.NE.2) GO TO 7
        IF (ISEC.EQ.0) GO TO 7
        IF (KONTRL(5).GT.0) KK=KK-I2
        DO 6 M=1,I2
          STRS(KK)=E(3,MTYP)
    6     KK=KK-1
  7   CONTINUE
```

New Segment of Code

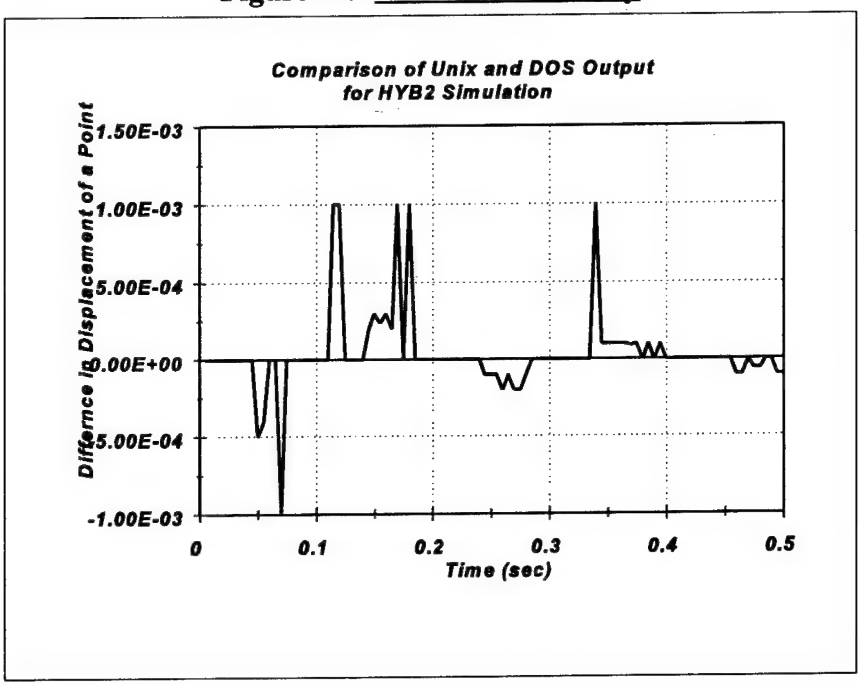
```
DO JE=1,NELE
ISEC=IX(11,JE)
IF (NOPT.EQ.2) THEN
  I1=1
  IF (ISEC.NE.0) I1=IPT(ISEC)
  IADD=41+6*I1
  IF (KONTRL(5).GT.0) IADD=41+8*I1
END IF
INDEX(JE+1)=INDEX(JE)+IADD
IND=INDEX(JE)-1
IF (NOPT.EQ.2 .OR. ISEC.NE.0) THEN
  IF (KONTRL(5).GT.0) KK=KK-I2
  DO M=1,I2
    STRS(KK)=E(3,MTYP)
    KK=KK-1
  END DO
END IF
```

4.5 Operational HSM Simulations.

As described above, BRC was successful in porting the full HSM model to the PC environment. Unfortunately, as explained below, the HSM is not general. Only three simulations were successfully compiled and executed: two Hybrid II Anthropomorphic Test Device (ATD) Head-Neck simulations and one Crest Ejection Seat simulation. The "Main" program for the version of the HSM which was successfully executed was "WHAM3.FOR." WHAM3.FOR, was compiled on an IBM Compatible PC (Gateway 2000 486-DX2) under Microsoft FORTRAN Powerstation Professional Development System v1.0. Software and run-time bugs were eliminated until we produced a program which would execute with the input file "hyb2.inp".

The output file produced by the PC executable was compared to an existing output file for the "hyb2.inp" which ran on the Silicon Graphics Incorporated (SGI) computer via an executable which was provided in the software archives. There were only very small differences in the numerical values output by each computer. The largest errors found were on the order of 10^{-3}. Figure 4-6 is a plot of the difference in the output position of a point on the spine computed on a PC and that of the same point computed on an execution on the SGI versus time. There was no way to tell which of the two solutions were most accurate, but it was assumed that the SGI was the more accurate because of its increased precision.

Figure 4-6 **Error Time History**



Most other outputs were either matched exactly or were off by a similar differences in values. Similar results were obtained from the input file "hyb22.inp"

The CREST ejection seat simulation was compared to archived outputs and confirmed that the executable was operating properly. The same input files were also executed on a Gateway 2000 P5-90 Pentium PC and results were in agreement with the archived and SGI outputs. Surprisingly, the CREST simulation took only 17 minutes to execute on a Pentium and 42 minutes on the SGI XS24. The run time for a Gateway 2000 DX2-66V (80486 DX2-66MHz) was 1 hour 30 minutes.

During the process of trying to duplicate archived simulations it was discovered that WHAM3.FOR had to be recompiled with different subroutine modules when the object being simulated was changed. This problem has been traced to a subroutine FREED.FOR which is unique to the problem at hand (it apparently sets initial conditions on the model). Thus, it appears that a different, custom FREED.FOR subroutine must be created for each problem type and compiled with the remainder of the source code to build an executable which will properly compute the desired model solution. This is not a good programming technique. The program could be made more general by rewriting the appropriate program sections. Although we examined both the code and the available documentation, BRC was unable to completely discover how the FREED.FOR subroutine is employed within the larger program to set initial conditions nor was it clear how a custom FREED.FOR subprogram is designed.

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SECTION 5

A NEW METHOD FOR CREATING INPUT FILES

5.0 Design of a New User Interface for the HSM.

A prototypical intuitive graphical interface was developed by BRC to allow the modification of HSM simulation input files and the display of HSM simulation output. The pre-processor/post-processor module is written in Visual Basic for Windows Version 3.0 and uses three third party custom controls: IndexTab 5.0 for tabbed screens, TrueGrid Pro 2.1 for data editing, and Chart FX 3.0 for the plotting capabilities. With this interface module the user has options to view, edit, and save input files, execute the HSM program, and view plots based on the output of the HSM program. The installation instructions for the User Interface Module and a listing of the source code can be found in Appendix B.

The menu for the User Interface has three options: **File**, **Solve**, and **Plot**. The **File Menu** provides the user with the options to open and save input files. Additionally, the file menu can be used to exit the program. To open an input file, select the **Open** option from the **File** menu as shown in Figure 5-1. The **Open** option brings up a dialog box that assists the user in finding and loading an input file. Once an input file is opened, the user can use the tabs to view the data. Some of the data lines have single records in the input file and others have multiple lines. The tabbed screens display field edit boxes for single record data lines and grids for multiple record data lines. Figure 5-1, which shows the Parameter Data Line, demonstrates a screen with edit boxes. A screen with a grid is presented in Figure 5-2 which displays the screen for the ICIF Data Lines. Subroutine ICIF apparently takes care of converting the input forcing function to the integration routine time scale and integrating accelerations and velocities as necessary to obtain a displacement versus time forcing function for input to the model.

The **Save** option from the **File** menu allows the user to save a variation of the original input file after editing the data. Like the **Open** option, the **Save** option brings up a dialog box that enables the user to select or specify a file name to use in saving the file. The data will be saved in the format which is read by the HSM program. Note that modifying and saving the input data is not enough to run a new HSM simulation -- several files of the model also must be recompiled, as was noted in Section 4.

When the **Solve** option from the menu is selected, the current input file is copied to a file named "hsm.inp" and is then used as input to the HSM program which is run in a DOS shell. After the HSM program completes its execution, the user can select the **Plot** menu option and view the plots generated from the output file. The plot display has a button labeled "Next" which the user can use to move to the next plot. When the last plot is being viewed, the button caption changes to "Done," and when pressed, the plot screen is removed. A screen display of an output file plot is shown in Figure 5-3.

Figure 5-1 Opening an Input File

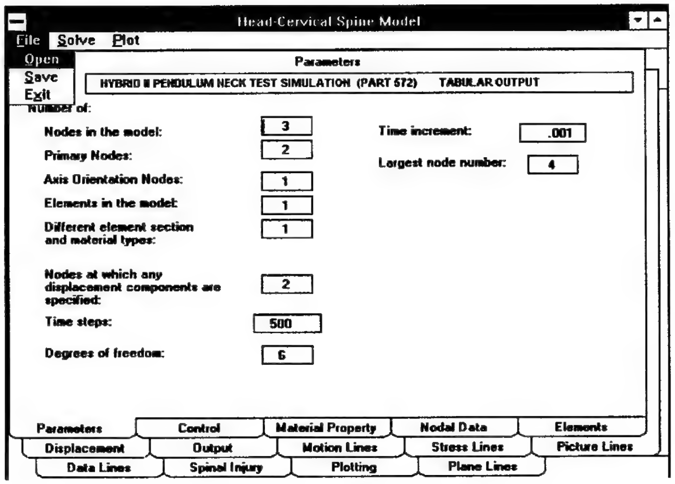


Figure 5-2 Input File Data Lines

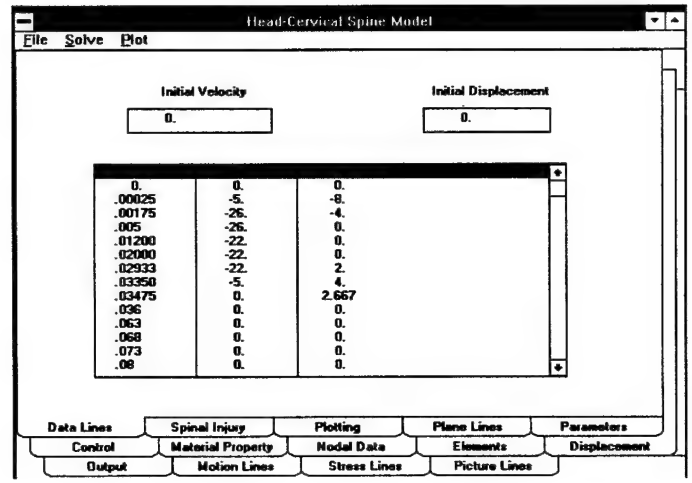
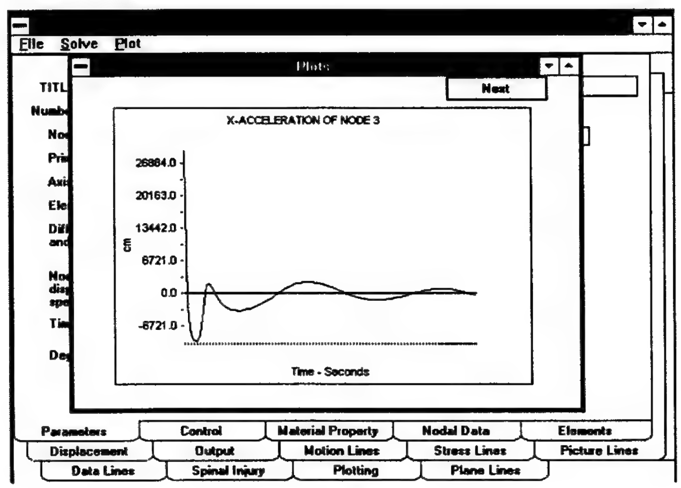


Figure 5-3 An Example of Plotted Output



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SECTION 6

VALIDITY OF THE HEAD-SPINE MODEL

6.0 Head-Spine Model Validity.

Questions regarding the validity of a mathematical model naturally arise and should be addressed in the conceptual phase of creating the model. Usually there is some preconceived notion that the model can be validated by comparing the model's predictions to actual data collected on the real world entity being simulated. The true value of a mathematical model lies in its ability to aid in analysis or design of a process or family of processes under study. In fact, in the opinion of the authors, the creation of the model should not be ***the*** objective at all! Nevertheless, the developers of the HSM stated,[1] "The principal objective of this investigation is the development of a three dimensional, discrete model of the spine and head." Later in their discussion, they implied that the HSM would be used operationally "to investigate the behavior of the spine" in situations "of practical importance."[1] Thus, despite the stated objective, it does appear that the developers of the original HSM recognized and understood the importance of operational validation in establishing the credibility of the model and its use for predictive simulation. Unfortunately, their development plan was not documented in the HSM Technical Reports (TRs),[1-4] nor were their validation studies extensive.

A review of the TRs indicates that the HSM was developed using generally accepted methods employed in the late 1970's and early 1980's. Unfortunately, the HSM and similar models of that time were developed in an academic atmosphere without the benefit of a rigorous development methodology. It appears to BRC that more time and resources were devoted to the actual construction and coding of the model than to its testing and validation. There is extensive documentation of the development of the equations of motion and the physical properties of the spine employed in the HSM. But, there is a relative lack of documentation of verification and validation activities. Some parametric and validation testing was done, but neither the written documentation nor the comments in the HSM code describe all the details of those studies. The available documentation of studies of the HSM cervical spine subsection's response to impulsive acceleration showed encouraging agreement with experimental data.[4] Nevertheless, only a few comparisons were made and the full range of possible head-neck motion was not explored. It is likely that a lack of experimental data or development resources, or both, limited the amount of validation work which was attempted.

BRC's aim was to investigate the feasibility of porting the existing HSM code to the PC environment. BRC has concluded that it is feasible to create a PC-based version of the HSM concept, but not by porting the existing code. The existing HSM program documentation and some of the archived code will be useful in creating a PC version. However, we are not confident that it will be possible to recover the original code and modify it to run in a more general purpose version on any platform without a substantial rewrite of the code. Three key factors, (1) the lack of comprehensive documentation, (2) the code implementation problems noted in Section 4.5, and (3) the limited amount of validation testing combine to substantially lower BRC's confidence in the validity of the archived HSM code. Moreover, in its present form, the HSM is anything but "user friendly." Much of the activity of developing a PC-based version of the HSM would

necessarily be devoted to creating user friendly interfaces. Thus, it is BRC's opinion that the most sensible course to follow would be to completely rewrite the HSM for the PC environment, to conduct that process using a development methodology designed to ensure the model and its limitations are documented, and to employ modern languages and programming constructs to create a model specifically for the PC platform.

There still remains a larger question of whether it is reasonable to expect a meaningful level of validation for the HSM in the future. In its most complex form, the HSM has 42 six degree-of-freedom nodes. This implies it has over 250 possible degrees-of-freedom (DOF). In its actual implementation (and in the real spine), many of the DOF are constrained so that, practically speaking, there are fewer DOF. However, in the model, those constraints are set by literally hundreds of parameters, many of whose values are not known precisely. Thus, the number of unique combinations of parameters makes it impractical to employ conventional parameterization methods with the 42-node version of the HSM. The developers of HSM obviously recognized this problem. Three of the four versions of HSM are simplified so that many of the vertebral nodes are lumped. This dramatically reduces the number of parameter combinations so that fitting the model output to data by parameter adjustment becomes more feasible. Nevertheless, only a few attempts to refine the HSM parameters were described in the project documentation.[1-4]

It appears that the HSM development team assumed that the HSM would be inherently valid if they created a model with a high degree of anatomical fidelity and set its physical properties using the best data obtainable. In fact, this approach has merit if the modeling objective is to understand the relationships between head-spine structure and its motion. It also summarizes what is known and unknown about the physical properties of the head and spine and suggests experiments aimed at their refinement. If, alternatively, the purpose of the model is to recreate (predict) the external motion of the head and spine to potentially injurious acceleration events, there are a number of issues related to validation which must be resolved before the HSM's validation can be established. Validation issues are highlighted in Figure 6-1, and discussed more fully in Paragraphs a-c.

Figure 6-1 HSM Validation Issues

- Do mathematically integrated discrete-element models adequately represent naturally integrated structures?
- Are biomechanical properties measured *in vitro* representative of those properties *in vivo*?
- Do biomechanical models of internal structures require validation against force-motion data measured on internal structures *in situ*?
- How does natural redundancy in biological structures affect the validation of mathematical models of that structure?

a. Integrated versus Discrete Nodes. There is a fundamental question related to how the mathematical model resulting from the assembly of models of the discrete elements which comprise the spine can actually simulate the behavior of the ligamentous spine and its associated structures *in vivo*. There is a related issue which can be stated as a question. Are the physical materials properties of individual tissues, obtained *in vitro,* valid when they are combined in the HSM to represented integrated tissues? The present HSM approach is based on the implicit assumption that *in vitro* properties are descriptive of *in vivo* properties and that any and all tissue interactions are adequately described by the equations.

b. Validation with External versus Internal Motion. With present technology, BRC sees little possibility of obtaining dynamic data on internal spinal responses to impulsive acceleration in humans. It may be possible to obtain such data on primate subjects, but as pointed out by the developers of the original model, there are issues relating to scaling primate data for application in human models.[1-4] In any case, primate data will be expensive to acquire and difficult to employ in validation of a human model. Then, the only data which will be readily available will be data on external motions, when what is actually needed to validate the motion of the skeleton *in situ* are internal data. This leads to the next issue.

c. Redundancy in Natural Structures. Natural biological structures are notoriously redundant. This provides "built in" protection against the failure of the entire organism being caused by failure of a single component. The spine is no exception. Spinal position is maintained reflexively by tension in literally hundreds of muscle segments whose actions often oppose each other, as in flexion and extension. This is highly relevant to a model which is based on a high degree

of anatomical fidelity. The hundreds of parameters necessary to mathematically specify the internal position, structure, and function of the spine will inherently contain the same kinds of redundancy as the actual spine. What this boilsdowntois that <u>external</u> motion of the head and spine will be insensitive to some of the model's parameters. Moreover, adjustments to a particular parameter value can be offset or nullified by adjustments to another. In mathematical terms, the model will be over determined in the context of modeling <u>external</u> motion of the head and spine. This leads to the conclusion that parameters are likely to be intercorrelated and insensitive to changes in the data describing <u>external</u> motion. Ultimately, this means that some parameters can be combined (lumped) or eliminated with little or no effect on the match between the model's predictions and the measured data.

The issues noted above circumscribe and help define the process necessary to create and validate a head-spine model whose predictions of external motions can be validated and subsequently related to internal forces and motions in the skeleton. BRC's recommendations for the development of a PC-based HSM derived from the original model are detailed in Section 7.0 of this report.

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SECTION 7

RECOMMENDATIONS

7.0 Recommendations.

Our research demonstrated that the HSM could be hosted and executed on Personal Computers (PC) under either the Microsoft MS-DOS or Microsoft Windows environment. However, the existing HSM code is largely undocumented and unstructured and was written with older versions of FORTRAN for the mainframe or workstation environment. Therefore, one of the major conclusions of the Phase I research program is that the HSM should be completely re-coded and documented using modern software and numerical routines tailored to the PC environment. Figure 7-1 outlines the technical steps necessary to create a partially validated, user-friendly HSM model for the Windows 95™ operating system. For the purposes of this report, the re-coded HSM will be called "HSM-PC." The following paragraphs discuss each technical step and its purpose.

7.1 Plan and Establish the Simulation Validation Protocol.

The development of a complex computer simulation such as the HSM-PC demands that a logical and rigorous protocol be employed to manage the risks of creating a software simulation that is difficult to employ and maintain in the "operational environment." The development program should therefore consist of a *planning phase*, during which the development activities are laid out and approved by the sponsors of the program, and an *application phase*, in which the actual development is carried out. BRC recommends that the HSM-PC development program follow a DOD developed methodology described by Knepell and Arango.[5] Their *confidence assessment* methodology provides the necessary controls and procedural framework for controlling the development of a complex simulation, while ensuring the validation of the modeling concept, code verification, documentation, and, most importantly, a systematic evaluation of the model's credibility. Figure 7-2 shows a diagram of the overall scheme. Figure 7-2 was adapted from Figure 2-3 of Reference 5. To explain the method, a few definitions are required.

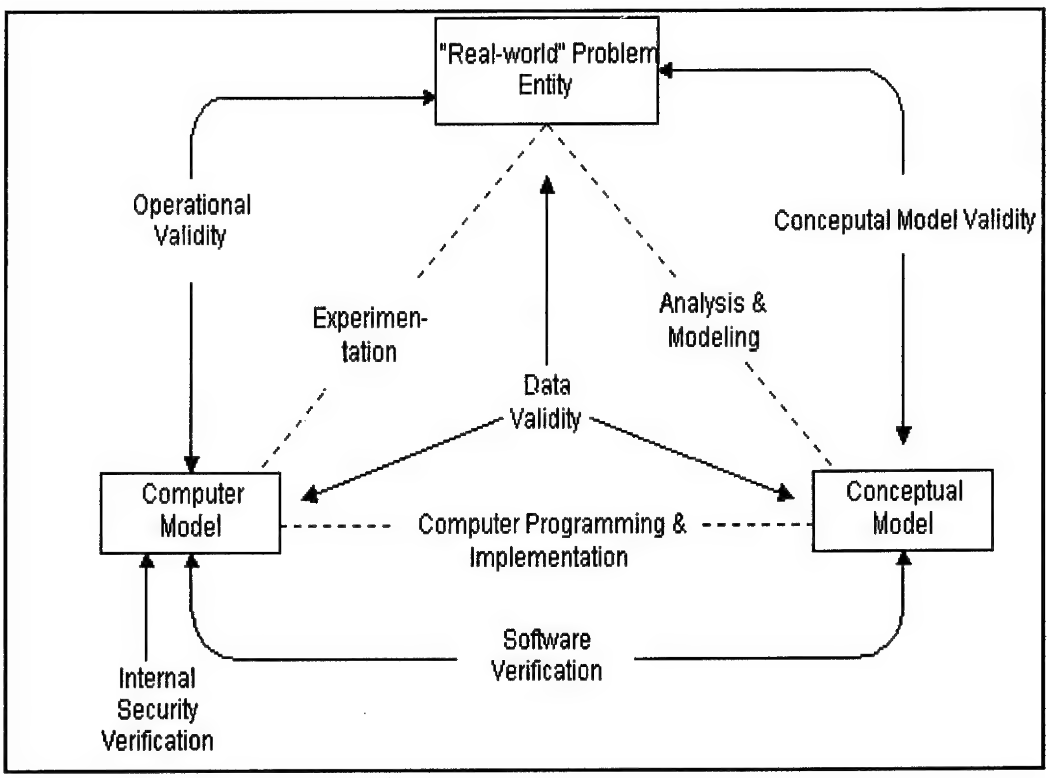
a. Conceptual Model Validation. The independent review of the purpose and concept of the model and its implementation to ensure the model addresses the relevant features of the "real-world" entity being simulated--in this case, the head and spine of the human being.

b. Software Verification. A process by which it is ensured that the software code computes the desired results. Essentially, this process verifies that the coded software implements the desired algorithms correctly and that it performs as desired.

Figure 7-1 Technical Objectives

- **Plan and Establish the Simulation Validation Protocol**
- **Create HSM Geometry and Materials Properties Database**
- **Re-Code The HSM for the Personal Computer Environment**
- **Partially Validate the HSM-PC**
- **Conduct Parametric Studies Using the HSM-PC Simulation**
- **Document the HSM-PC and Its Applicability**

Figure 7-2 Simulation Validation Process



c. Operational Validation. This is the classic validation process necessary of any computer modeling program. Operational validation ensures that the computer simulation has a satisfactory range of accuracy within its intended domain of applicability and that the scope of its domain is defined and documented. In relation to the HSM-PC, operational validation will ensure that the HSM-PC predictions and their errors are understood and that its domain of applicability is known.

d. Data Validation. The process of documenting the data employed in generating model parameters and equations. For the HSM-PC this will consist of creating, updating, and auditing a database of geometry and materials properties necessary to specify the physical structure and the properties of the constituent tissues of the spine and its associated structures.

e. Internal Security. Internal security establishes a configuration control procedure and protects the code against tampering or unauthorized modification.

As shown in Figure 7-2, the entire process of *confidence assessment* is designed to ensure the "real-world problem entity." In this case, the human head and spine are represented and simulated in the computer model as logically and accurately as possible. The entire process is managed by an Assessment Team whose members are listed in Figure 7-3.

Figure 7-3 Assessment Team Representatives

- Project Management
- Development Team
- Users
- Community Experts

The roles of the Assessment Team members are briefly described below.

a. Management. A member from program Management will be designated to serve as an informed member of the Assessment Team. The role of management in the process is to provide support and direction as necessary to ensure sufficient resources are available to complete the development program on schedule and within budget.

b. Development. Developers include the programmers, consultants, scientists, and computer infrastructure experts necessary to implement the development plan for the HSM-PC development.

c. Users. The users group represents knowledgeable scientists and practitioners who possess the necessary skill and technical knowledge to employ the model in an investigative or problem solving environment. Members of this group should not come from the Development community.

d. Community Experts. To provide an objective review of the HSM-PC and its development process, subject matter experts (SME's) will be employed as members of the review team.

The model evaluation approach is detailed in Simulation Validation.[5] This process is too extensive to be completely described here. Briefly, it provides: (1) the detailed methodology and tools to continuously assess, verify, validate, and document a complex software simulation during its development; (2) an explicit method to assess the credibility of the model's simulations and its domain of applicability; and (3) an audit trail to support the confidence assessment process governed by the Assessment Team. Although the confidence assessment methodology will add both time and expense to the HSM-PC development effort, it will ensure that the HSM-PC software is properly assessed and documented.

7.2 Create a Database of the Geometry and Materials Properties Data Contained in the AAMRL HSM.

The researchers who created the original AAMRL HSM[1-4] created an extensive collection of anatomic, geometric, and materials property data relating to the spine and is associated tissues. These data were documented in the program Technical Reports or in the HSM code. BRC reviewed the geometry and materials properties data related to the HSM and found them to be generally complete. However, no audit was conducted to confirm that the data contained in the HSM documentation was actually the best available.

As noted above, the original HSM data is somewhat dated. A survey of the more recent literature should be conducted to support a systematic update and audit of the physical geometry and biomechanical properties of the head, spine, and associated tissues. Once the update and audit are complete, the geometry and materials properties data should be loaded in a "Properties Database" for on-line access by the HSM-PC. This database should be implemented in an environment which will be independently accessible for other purposes as a stand alone database.

7.3 Create User Friendly Interfaces

As shown in Figure 7-4, the HSM software uses an input file in card image format which is tedious to assemble and difficult to decode. The user is required to encode the initial state of the model as a precise sequence of control and data records. The program output is a large text file which includes graphical depictions of the model states. To aid review of the output, the user has access to a set of drawing commands which allows some flexibility in viewing the results of the analysis. The Phase I effort added a new prototype user interface which allows the user to view, edit and save input files. The screen pages provide labels for the input data and in some cases choices of possible field values. This Phase I interface also reads the output file generated by the analysis and displays X-Y plots on the screen based on the variable values computed by the analysis.

Both the input and output GUIs for the HSM-PC should be studied and tailored to the PC environment. Of particular importance are provisions to manage the large numbers of input specifications necessary to specify the initial conditions and forcing functions for the HSM-PC. The GUI should display the initial position of the head and spine and its supporting structures as well as allow display of the forcing function. The use of the Materials Properties Database will facilitate preserving and setting parameters which are not changed frequently. The output GUI should be able to display "snapshots" of two- and three-dimensional views of the position of the head and spine as a function of time. The user should be able to easily create graphical displays of the position, velocity, and acceleration of particular nodes versus time or displays of the kinematic variables versus each other and the amplitude of the forcing function.

7.4 Re-Code the HSM for the PC Environment.

It is suggested that a "build-up" approach be employed to ensure the proper verification and documentation of the software code. Figure 7-5 illustrates the suggested program architecture. It is recommended that the HSM-PC be hosted on IBM compatible PC's running the Windows 95™ operating system. This will ensure its compatibility with the 32-bit environment and dictate that a more capable machine be employed to execute the code. The Input/Output GUI's should be programmed in Microsoft Visual Basic™ and/or Microsoft Visual C++™ and the numerical analysis and solver modules should be written in a language which emphasizes speed of execution such as Microsoft's Fortran-90™. The development team should consider the use of computer assisted software engineering (CASE) tools such as SD/FAST. SD/FAST is a multibody dynamics modeling application for the PC which generates the Kane's Equations[10] (differential equations) as Fortran source code subroutines which can be incorporated directly in independently developed Fortran code. The geometry and materials properties database will be implemented in a compatible database application such as Microsoft Access™. All of the software applications should employ the Object Oriented Programming (OOP) technology. The choice of a single software manufacturer and the OOP programming constructs will ensure that there is mutual compatibility between the operating system and the major programming applications employed to create the HSM-PC.

Figure 7-4 <u>Data Flow of Original HSM</u>

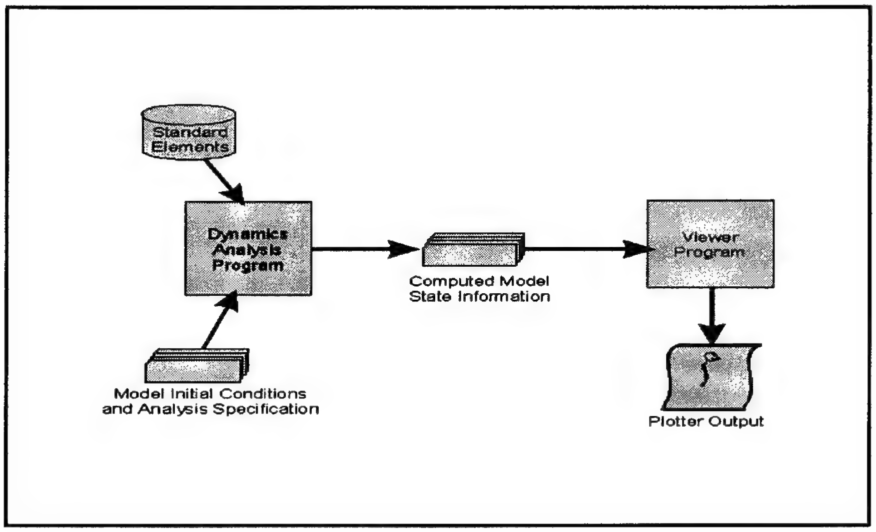
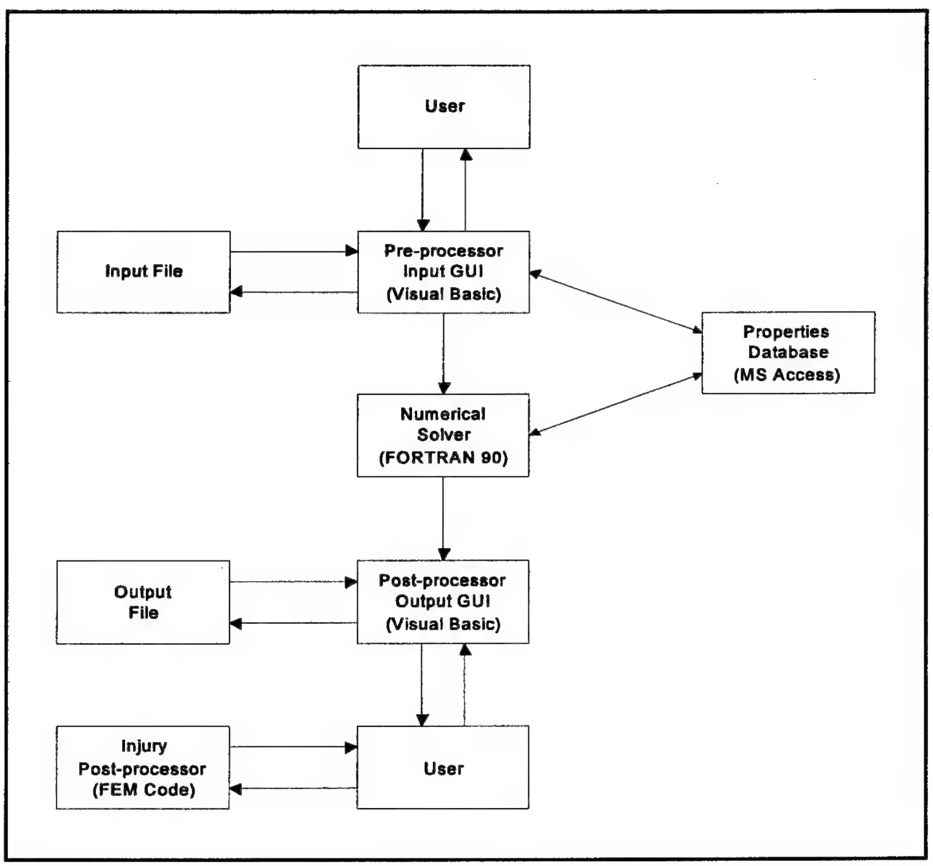


Figure 7-5 <u>Overall Program Structure</u>



The use of a build up approach to create the model will ensure that the development team develops the appropriate discipline demanded by the CA process early in the program. It is suggested that the sequence of creating subsegment models follow those outlined in Figure 7-6, which is a roadmap of the suggested development process. As shown, a full, 3-D head-cervical spine model should be developed and partially validated to prove the viability of the development process. The head-cervical spine model will be a useful tool in its own right and independent evaluation and further validation could begin on that model subsection before the entire development process is complete.

7.5 Validation of the HSM-PC Simulation.

Operational validation of the simulations produced by subsystem modules of the HSM-PC should commence as soon as the software subsystem modules are created and coded. Predictive validation against experimental data or known principles of physics should take place where possible.

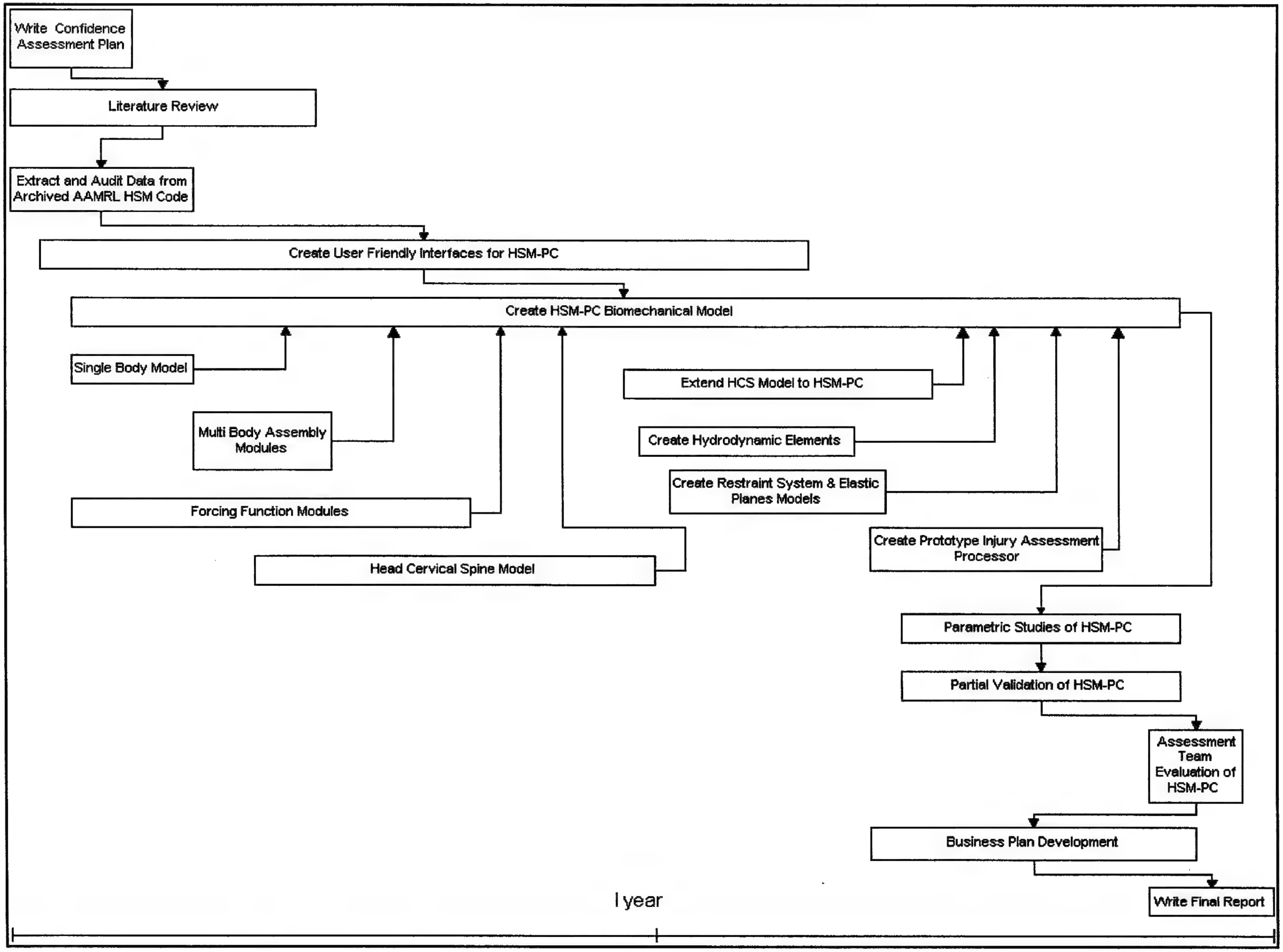
Because the HSM-PC will be complex and will contain many degrees of freedom, the scope of its predictions will be enormous. It will, therefore, be virtually impossible to validate every possible prediction of the HSM-PC. Nevertheless, an attempt should be made to employ suitable data where feasible to define the scope of the HSM-PC applicability. Within those domains where the use of the HSM-PC is verified and validated, data on its accuracy should be sought to allow the user to gauge the utility of the HSM-PC simulation predictions in relation to other analytic tools or actual data.

7.6 Conduct Parametric Studies with the HSM-PC.

Parametric Studies should be conducted to examine the sensitivity of the HSM-PC simulation to changes in parameter values. Parametric investigations will reveal which parameters must be set relatively precisely to ensure the HSM-PC simulations are representative of the dynamics of the human spine. Parameter sensitivities and covariance issues should be addressed as early as possible in the process so that redundant or extraneous parameters can be eliminated from the model. This process will ensure parsimony in model parameters and a verified and validated HSM-PC.

In the process required to "fit" the HSM-PC to experimental data, parameters should be varied and the response of the models compared to experimental data until "best fits in the least squares sense"[11] are obtained. However, as noted above, it is to be expected that a model with many degrees of freedom will be somewhat over determined, i.e., there will be interdependence and covariance between the model parameters. The interdependence between parameters and their covariance should be studied, perhaps using classic parametric sensitivity study methods such as Monte-Carlo.[12-15] Another approach might be to examine the model residuals (the difference between predicted and actual motion) for their structure to define "how much" of the actual motion is/or is not simulated by the model. The relationships between the residuals and the forcing function amplitude and its frequency content should also be investigated. The iterative reduction of parameter

Figure 7-6 Roadmap to Development Process



correlation will likely be a tedious process and will be very demanding on computer resources. It will require putting the Numerical Solver inside a non-linear optimization structure and repeatedly finding best fit solutions as the parameters are varied. If this process is started early in the development process, an intuitive understanding of parameter sensitivities will likely evolve which will serve the development team as the development proceeds. Parameters whose values dominate the model response characteristics and those which produce little or no change in the model's response or its residuals should be identified and studied in detail. Parameters to which the model's response is insensitive should be flagged as candidates for elimination from the final model and their effects should be tracked as the model's complexity increases.

7.7 Document the HSM-PC and Its Applicability.

The confidence assessment (CA) methodology described in Reference 1 ensures that the basic material from which the final documentation is drawn is developed in a complete and systematic manner. The CA process is iterative. It should be applied at the subsystem level as the code for major subsystems is developed. After each evaluation, a report should be issued which documents the findings of the subsystem CA.

7.8 Conclusion.

Biodynamic Research Corporation (BRC) of San Antonio, TX, completed an SBIR Phase I project to port the Air Force's Head-Spine Model (HSM) to a PC-DOS environment and provide a recommended roadmap for the future of the HSM. The impetus for this project was the Air Force's desire to have a software tool capable of modeling the internal forces and motions of the human head and spine during impulsive acceleration events.

Although the code transfer was successful, BRC discovered several "problems" with the Head-Spine Model which made creating a general purpose HSM code impossible. It is BRC's belief that the material and geometry data of the HSM model, as well as some of the model algorithms and logic, can best be used by recreating the model in an object-oriented software language such as C++ or Fortran 90. The cost and effort required to understand the current version, debug coding and algorithm errors, and document the code is far greater than simply extracting the useful data and starting over. Therefore, BRC recommends that the HSM be rewritten for the PC environment and that the development program be conducted under the confidence assessment process outlined above.

SECTION 8

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APPENDIX A

HSM CODE FOR A PC-DOS COMPUTER

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```
      SUBROUTINE ALPHAP (NUMNP,XC,YC,ZC,EULCO,UD,INMESH)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
Cbrc
Cbrc  REPLACED COMMONS WITH INCLUDES AND ELIMINATED GO TO'S - DJP
Cbrc
      INCLUDE 'ADJUST.COM'

      COMMON /IPLOT/ PLTDCD,FSTPLT(9),PELVIS,IDPN(10),NPPTS(10),IDP(10),
     1          INT,PRNT
      INTEGER  PLTDCD, PRNT
      DIMENSION EULCO(3,3,NBLAMB), XC(NXC), YC(NYC), ZC(NZC), UD(NX1),
     1        INMESH(NINMEH)
C
      INTEGER  PELVNN
      INTEGER T1,SPNN,BPNN,TPNN,HEADNN
      INTEGER C7,C2
      INTEGER STERNM,RIBBGN,RIBEND,BPR,BPL
      DATA ITYPE/4HBODY/
      DATA CERV/3HCYN/
      IPTC=0
      PELVNN = INMESH(231)
      L5=INMESH(232)
C
C.... L5=INMESH(248)
C
      T1=INMESH(248)
      HEADNN=INMESH(249)
      NNSP=16
      NNBP=15
      NNTP=21
      SPNN=INMESH(NNSP)
      BPNN=INMESH(NNBP)
      TPNN=INMESH(NNTP)
C
C.... BPNN=INMESH(223)
C.... TPNN=INMESH(229)
C.... SPNN=INMESH(224)
C
      NDBP=6*(BPNN-1)
      XOFF=XC(BPNN)+UD(NDBP+1)
      YOFF=YC(BPNN)+UD(NDBP+2)
      ZOFF=ZC(BPNN)+UD(NDBP+3)
C
      IF ( PELVIS .EQ. '     ' ) THEN
       NBPPELV=INMESH(7)
       NDPELV = 6*(NBPPELV-1)
       X = XC(NBPPELV)+UD(NDPELV+1)-XOFF
       Y = YC(NBPPELV)+UD(NDPELV+2)-YOFF
       Z = ZC(NBPPELV)+UD(NDPELV+3)-ZOFF
       NODE = 1
C
       IF ( PRNT .EQ. 0 )
     1  WRITE (6,904)  NODE , IPTC , ITYPE, X, Y, Z,
     2          (( EULCO(M,L,PELVNN), M=1,3), L=1,3,2)
       WRITE (7,903)  NODE , IPTC , ITYPE, X, Y, Z,
     1          (( EULCO(M,L,PELVNN), M=1,3), L=1,3,2)
      END IF
C
C
      DO KNODE=L5,T1
       NDSP=6*(SPNN-1)
       NDBP=6*(BPNN-1)
       NDTP=6*(TPNN-1)
C
       V3X=XC(TPNN)-XC(BPNN)+UD(NDTP+1)-UD(NDBP+1)
       V3Y=YC(TPNN)-YC(BPNN)+UD(NDTP+2)-UD(NDBP+2)
       V3Z=ZC(TPNN)-ZC(BPNN)+UD(NDTP+3)-UD(NDBP+3)
C
       V2X=XC(SPNN)-XC(BPNN)+UD(NDSP+1)-UD(NDBP+1)
       V2Y=YC(SPNN)-YC(BPNN)+UD(NDSP+2)-UD(NDBP+2)
       V2Z=ZC(SPNN)-ZC(BPNN)+UD(NDSP+3)-UD(NDBP+3)
C
       V1X=V2Y*V3Z-V3Y*V2Z
       V1Y=V2Z*V3X-V3Z*V2X
```

```
      V1Z=V2X*V3Y-V3X*V2Y
C
      V1L=DSQRT(V1X*V1X+V1Y*V1Y+V1Z*V1Z)
C
      V1X=V1X/V1L
      V1Y=V1Y/V1L
      V1Z=V1Z/V1L
C
      V3L=DSQRT(V3X*V3X+V3Y*V3Y+V3Z*V3Z)
C
      V3X=V3X/V3L
      V3Y=V3Y/V3L
      V3Z=V3Z/V3L
C
      X=XC(BPNN)+UD(NDBP+1)-XOFF
      Y=YC(BPNN)+UD(NDBP+2)-YOFF
      Z=ZC(BPNN)+UD(NDBP+3)-ZOFF
C
      NODE=KNODE-L5+2
C
      IF ( PRNT .EQ. 0 )
     1   WRITE (6,904) NODE,IPTC,ITYPE,X,Y,Z,V1X,V1Y,V1Z,V3X,V3Y,V3Z
      WRITE (7,903) NODE,IPTC,ITYPE,X,Y,Z,V1X,V1Y,V1Z,V3X,V3Y,V3Z
C
      NNSP=NNSP+13
      NNBP=NNBP+13
      NNTP=NNTP+13
      SPNN=INMESH(NNSP)
      BPNN=INMESH(NNBP)
      TPNN=INMESH(NNTP)
C
     END DO
C
C
     IF (HEADNN.NE.19 .OR. HEADNN.NE.21) THEN
      C7=INMESH(340)
      C2=INMESH(345)
      SPNN=INMESH(268)
      BPNN=INMESH(256)
      TPNN=INMESH(257)
      NODE=0
C
      DO KNODE=C7,C2
       NDSP=6*(SPNN-1)
       NDBP=6*(BPNN-1)
       NDTP=6*(TPNN-1)
C
       V3X=XC(TPNN)-XC(BPNN)+UD(NDTP+1)-UD(NDBP+1)
       V3Y=YC(TPNN)-YC(BPNN)+UD(NDTP+2)-UD(NDBP+2)
       V3Z=ZC(TPNN)-ZC(BPNN)+UD(NDTP+3)-UD(NDBP+3)
C
       V2X=XC(SPNN)-XC(BPNN)+UD(NDSP+1)-UD(NDBP+1)
       V2Y=YC(SPNN)-YC(BPNN)+UD(NDSP+2)-UD(NDBP+2)
       V2Z=ZC(SPNN)-ZC(BPNN)+UD(NDSP+3)-UD(NDBP+3)
C
       V1X=V2Y*V3Z-V3Y*V2Z
       V1Y=V2Z*V3X-V3Z*V2X
       V1Z=V2X*V3Y-V3X*V2Y
C
       V1L=DSQRT(V1X*V1X+V1Y*V1Y+V1Z*V1Z)
C
       V1X=V1X/V1L
       V1Y=V1Y/V1L
       V1Z=V1Z/V1L
C
       V3L=DSQRT(V3X*V3X+V3Y*V3Y+V3Z*V3Z)
C
       V3X=V3X/V3L
       V3Y=V3Y/V3L
       V3Z=V3Z/V3L
C
       X=XC(BPNN)+UD(NDBP+1)-XOFF
       Y=YC(BPNN)+UD(NDBP+2)-YOFF
       Z=ZC(BPNN)+UD(NDBP+3)-ZOFF
C
       NODE=NODE+1
```

```
      IPTC=32
      IF (NODE.EQ.1) IPTC=20
C
      IF ( PRNT .EQ. 0 )
     1  WRITE (6,904) NODE,IPTC,CERV,X,Y,Z,V1X,V1Y,V1Z,V3X,V3Y,V3Z
      WRITE (7,903) NODE,IPTC,CERV,X,Y,Z,V1X,V1Y,V1Z,V3X,V3Y,V3Z
C
      SPNN=SPNN+1
      BPNN=BPNN+2
      TPNN=TPNN+2
C
     END DO
    END IF
C
    IF (NUMNP.GE.471) THEN
     STERNM=INMESH(471)
     RIBBGN=INMESH(451)
     RIBEND=INMESH(469)
     NNBPR=296
     NNBPL=303
     BPR=INMESH(NNBPR)
     BPL=INMESH(NNBPL)
     IPTC=0
C
     IF (NUMNP.LT.STERNM) RETURN
C
     DO KNODE=RIBBGN,RIBEND,2
      NDBP=6*(BPR-1)
      X=XC(BPR)+UD(NDBP+1)-XOFF
      Y=YC(BPR)+UD(NDBP+2)-YOFF
      Z=ZC(BPR)+UD(NDBP+3)-ZOFF
C
      NODE=KNODE-RIBBGN+19
C
      IF ( PRNT .EQ. 0 )
     1  WRITE (6,904) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,KNODE),
     2          M=1,3),L=1,3,2)
      WRITE (7,903) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,KNODE),M=1,3),
     1          L=1,3,2)
C
      NDBP=6*(BPL-1)
      X=XC(BPL)+UD(NDBP+1)-XOFF
      Y=YC(BPL)+UD(NDBP+2)-YOFF
      Z=ZC(BPL)+UD(NDBP+3)-ZOFF
C
      INODE=KNODE+1
      NODE=INODE-RIBBGN+19
C
      IF ( PRNT .EQ. 0 )
     1  WRITE (6,904) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,INODE),
     2          M=1,3),L=1,3,2)
      WRITE (7,903) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,INODE),M=1,3),
     1          L=1,3,2)
C
      NNBPR=NNBPR+14
      NNBPL=NNBPL+14
      BPL=INMESH(NNBPL)
      BPR=INMESH(NNBPR)
C
     END DO
C
     NDSTER=6*(STERNM-1)
     X=XC(STERNM)+UD(NDSTER+1)-XOFF
     Y=YC(STERNM)+UD(NDSTER+2)-YOFF
     Z=ZC(STERNM)+UD(NDSTER+3)-ZOFF
C
     NODE=STERNM-RIBBGN+19
C
     IF ( PRNT .EQ. 0 )
     1 WRITE (6,904) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,STERNM),
     2          M=1,3),L=1,3,2)
     WRITE (7,903) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,STERNM),M=1,3),
     1          L=1,3,2)
    END IF
C
    NDHEAD = 6 * ( HEADNN-1 )
```

```
      X=XC(HEADNN)+UD(NDHEAD+1)-XOFF
      Y=YC(HEADNN)+UD(NDHEAD+2)-YOFF
      Z=ZC(HEADNN)+UD(NDHEAD+3)-ZOFF
C
      NODE=40
C
      IF ( PRNT .EQ. 0 )
     1 WRITE (6,904) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,HEADNN),M=1,3),
     2            L=1,3,2)
      WRITE (7,903) NODE,IPTC,ITYPE,X,Y,Z,((EULCO(M,L,HEADNN),M=1,3),
     1            L=1,3,2)
C
C
      RETURN
C
  903 FORMAT (I2,I2,A4,3F8.3,6F8.6)
  904 FORMAT (1X,I2,I2,A4,3F8.3,6F8.6)
      END
```

```
      SUBROUTINE ASSBLE (IX,XC,YC,ZC,E,SMASS,RMASS,DICOS,INDEX,STRS,IPT,
     1AL)
C
Cbrc
Cbrc  REPLACED COMMONS WITH INCLUDES AND MOST GOTOS WITH BLOCK IF AND DO'S
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      INCLUDE 'SIZE.COM'

      COMMON /NEIGEN/ NAM,NR
      DIMENSION IX(14,NIX), XC(NXC), YC(NYC), ZC(NZC), E(12,NE),
     1      SMASS(NSMASS), RMASS(3,3,NBLAMB), EULCO(3,3),
     2      DICOS(3,3,NDICOS), INDEX(NINDEX), STRS(NSTRS),
     3      IPT(NIPT), AL(NAL)
      INCLUDE 'CONTRL.COM'
      INCLUDE 'NUMINT.COM'

      IF(KONTRL(3).EQ.2) WRITE(6,201)

      MEQ=NNODE*NDGREE
      NEQ=NPRI*NDGREE
      ISEC=0
      MAXIPT=1

      IF (NUMSEC.NE.0) THEN
       READ (5,901) (IPT(LEN),LEN=1,NUMSEC)
       DO LEN=1,NUMSEC
        IF (MAXIPT.LT.IPT(LEN)) MAXIPT=IPT(LEN)
       END DO
      END IF

      DO I=1,NPRI
       NN=(I-1)*NDGREE
       DO M=1,3
        LEN=NN+3
        RMASS(M,M,I)=SMASS(LEN+M)
       END DO
      END DO

      IADD=1
      INDEX(1)=1
      DO JE=1,NELE
       NOPT=IX(10,JE)
       ISEC=IX(11,JE)
       IF (NOPT.EQ.1) IADD=16
       IF (NOPT.EQ.3) IADD=46
       IF (NOPT.EQ.4) IADD=40
       IF (NOPT.EQ.5) IADD=48+21*ISEC
       IF (NOPT.EQ.6) IADD=5
       IF (NOPT.EQ.2) THEN
        I1=1
        IF (ISEC.NE.0) I1=IPT(ISEC)
        IADD=41+6*I1
        IF (KONTRL(5).GT.0) IADD=41+8*I1
       END IF
       INDEX(JE+1)=INDEX(JE)+IADD
       IND=INDEX(JE)-1
       IF (NOPT.EQ.2 .OR. ISEC.NE.0) THEN
        MTYP=IX(9,JE)
        KK=IADD+IND
        I2=2*I1
        IF (KONTRL(5).GT.0) KK=KK-I2
        DO M=1,I2
         STRS(KK)=E(3,MTYP)
         KK=KK-1
        END DO
       END IF
       IF (NOPT.EQ.5) THEN
        ID=INDEX(JE)+27
        IF (MAXIPT.LT.ISEC) MAXIPT=ISEC
        NIND = NSTRS-IND
       ELSE IF (NOPT.NE.6) THEN
        CALL BASME (JE,NDGREE,IX,XC,YC,ZC,E,SMASS,DICOS,RMASS,AL)
       ELSE
```

```
         CYCLE
        END IF
       END DO

       DO I=1,NPRI
        NN=(2*I-1)*3
        DO MJ=1,3
         DO JM=1,3
          EULCO(MJ,JM)=0.D0
         END DO
        END DO
        IF (RMASS(1,1,I).EQ.0.) CYCLE
        IF (KONTRL(3).NE.0) THEN
         IF (KONTRL(3).EQ.2) GO TO 202
         EULCO(1,1)=1.D0
         EULCO(2,2)=1.D0
         EULCO(3,3)=1.D0
         SMASS(NN+1)=RMASS(1,1,I)
         SMASS(NN+2)=RMASS(2,2,I)
         SMASS(NN+3)=RMASS(3,3,I)
         GO TO 14
        END IF
        RMASS(2,1,I)=RMASS(1,2,I)
        RMASS(3,1,I)=RMASS(2,2,I)
        DO MJ=1,3
         RMASS(MJ,2,I)=RMASS(MJ,3,I)
        END DO
C
        NAM = 3 + (3*3 - 3)/2
        NR = 3*3
        CALL EIGEN (RMASS(1,1,I),EULCO,3,0)
C
C....  NORMALIZE AND DETERMINE THIRD EIGENVECTOR FOR RIGHT HAND SYSTEM
C
        DO NE=1,2
         ENORM=DSQRT(EULCO(1,NE)*EULCO(1,NE)+EULCO(2,NE)*EULCO(2,NE)+
     1               EULCO(3,NE)*EULCO(3,NE))
         EULCO(1,NE)=EULCO(1,NE)/ENORM
         EULCO(2,NE)=EULCO(2,NE)/ENORM
         EULCO(3,NE)=EULCO(3,NE)/ENORM
        END DO
        EULCO(1,3)=EULCO(2,1)*EULCO(3,2)-EULCO(2,2)*EULCO(3,1)
        EULCO(2,3)=EULCO(3,1)*EULCO(1,2)-EULCO(3,2)*EULCO(1,1)
        EULCO(3,3)=EULCO(1,1)*EULCO(2,2)-EULCO(1,2)*EULCO(2,1)
C
C....  AVERAGE INERTIAS
C
        AMASS=(RMASS(1,1,I)+RMASS(3,1,I)+RMASS(3,2,I))/3.D0
        SMASS(NN+1)=AMASS
        SMASS(NN+2)=AMASS
        SMASS(NN+3)=AMASS
C
C....  IF(NNODE.EQ.11) GO TO 210
C
        SMASS(NN+1)=RMASS(1,1,I)
        SMASS(NN+2)=RMASS(3,1,I)
        SMASS(NN+3)=RMASS(3,2,I)
        GO TO 14
C
C READ-IN X-BAR, Y-BAR VECTORS.
C
 202   READ(5,203)NODE,EULCO(1,1),EULCO(2,1),EULCO(3,1),
     1        EULCO(1,2),EULCO(2,2),EULCO(3,2)
       WRITE(6,204) NODE
C
C NORMALIZE X-BAR, Y-BAR VECTORS.
C
       DO NE=1,2
        ENORM=DSQRT(EULCO(1,NE)*EULCO(1,NE)+EULCO(2,NE)*EULCO(2,NE)
     1                 +EULCO(3,NE)*EULCO(3,NE))
        EULCO(1,NE)=EULCO(1,NE)/ENORM
        EULCO(2,NE)=EULCO(2,NE)/ENORM
        EULCO(3,NE)=EULCO(3,NE)/ENORM
       END DO
C
C FIND Z-BAR UNIT VECTOR FROM CROSS-PRODUCT OF X-BAR AND Y-BAR.
```

```
C
      EULCO(1,3)=EULCO(2,1)*EULCO(3,2)-EULCO(2,2)*EULCO(3,1)
      EULCO(2,3)=EULCO(3,1)*EULCO(1,2)-EULCO(3,2)*EULCO(1,1)
      EULCO(3,3)=EULCO(1,1)*EULCO(2,2)-EULCO(1,2)*EULCO(2,1)
      DO NE=1,3
       WRITE(6,207)EULCO(NE,1),EULCO(NE,2),EULCO(NE,3)
      END DO
C
  14   DO MJ=1,3
       DO JM=1,3
        RMASS(MJ,JM,I)=EULCO(MJ,JM)
       END DO
      END DO
     END DO

     WRITE (6,902)
     WRITE (6,903) (SMASS(LS),LS=1,NEQ)
C
C.... CALCULATE R-ZERO AND R-ZERO-BAR FOR ALL ELEMENTS AND
C....    STORE IN  STRS  ARRAY
C
     DO I=1,NELE
      MJ=INDEX(I)-1
      NOPT=IX(10,I)
      LOOP1=2
      LOOP2=2
      IPADD=2
      IF (NOPT.EQ.5) THEN
       LOOP1=3
       LOOP2=1
       IPADD=3
      END IF
      J3=4
      DO J1=1,LOOP1
       IF (NOPT.EQ.4) GO TO 21
       K=IX(J1,I)
       KK=IX(J1+IPADD,I)
C
C....    SKIP BODY COMPONENT CALCULATION FOR SPRING ELEMENTS (TYPE=1)
C
       IF (NOPT.EQ.1) GO TO 23
       DO L=1,LOOP2
        DO M=1,3
         SUM=0.D0
         MJ=MJ+1
         KEV=L
         IF (NOPT.EQ.5) KEV=3
         DO N=1,3
          SUM=SUM+RMASS(N,M,KK)*DICOS(N,KEV,I)
         END DO
         STRS(MJ)=SUM
        END DO
       END DO
       GO TO 23
C
C....    LOOP FOR R-ZERO AND R-ZERO-BAR FOR PVP ELEMENT(TYPE=4)
C
  21   J2=J1-1
       J3=0
       J4=3*J2
  22   J3=J3+1
       K=IX(J3+J4,I)
       KK=IX(7+J2,I)
C
C....    CALCULATE R-ZERO
C
  23   STRS(MJ+1)=XC(K)-XC(KK)
       STRS(MJ+2)=YC(K)-YC(KK)
       STRS(MJ+3)=ZC(K)-ZC(KK)
       MK=MJ
       MJ=MJ+3
C
C....    CALCULATE R-ZERO-BAR
C
       DO NN=1,3
        MJ=MJ+1
```

```
      STRS(MJ)=RMASS(1,NN,KK)*STRS(MK+1)+RMASS(2,NN,KK)*STRS(MK+2)
  1          +RMASS(3,NN,KK)*STRS(MK+3)
     END DO
     IF (J3.LT.3) GO TO 22
    END DO
   END DO
   RETURN
C
 201 FORMAT('0 INITIAL BODY UNIT VECTOR COMPONENTS',/,
  1     ' AT NODE')
 203 FORMAT(I5,5X,6F10.4)
 204 FORMAT(' ',5X,I5)
 207 FORMAT(' ',9X,3F10.4)
 901 FORMAT (16I5)
 902 FORMAT (/5X,37HTOTAL PRIMARY NODE MASS ARRAY   SMASS/)
 903 FORMAT (2X,1P6D20.4)
   END
```

```
      SUBROUTINE BASME (I,NDGREE,IX,XC,YC,ZC,E,SMASS,DICOS,RMASS,AL)
C
Cbrc
Cbrc  CHANGED COMMON TO INCLUDE AND GOTO'S TO BLOCK IF AND DO
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      DIMENSION XC(NXC),YC(NYC),ZC(NZC),E(12,NE),IX(14,NIX),
     1       SMASS(NSMASS)
      DIMENSION DICOS(3,3,NDICOS), AL(NAL), RMASS(3,3,NBLAMB)
C
C.... CHECK FOR PVP ELEMENTS  (ETYPR=4)
C
      IF (IX(10,I).NE.4) THEN
       N1=IX(1,I)
       N2=IX(2,I)
       N3=IX(3,I)
       N4=IX(4,I)
       XX=XC(N2)-XC(N1)
       YY=YC(N2)-YC(N1)
       ZZ=ZC(N2)-ZC(N1)
       AL(I)=DSQRT(XX*XX+YY*YY+ZZ*ZZ)
C
C.... SKIP DIRECTION COSINE CALCULATION FOR SPRING ELEMENTS
C
       IF (IX(10,I).NE.1) THEN
        DICOS(1,1,I)=XX/AL(I)
        DICOS(2,1,I)=YY/AL(I)
        DICOS(3,1,I)=ZZ/AL(I)
        LOCNOD=IX(8,I)
        VAX=XC(LOCNOD)-XC(N1)
        VAY=YC(LOCNOD)-YC(N1)
        VAZ=ZC(LOCNOD)-ZC(N1)
        A=DSQRT(VAX*VAX+VAY*VAY+VAZ*VAZ)
        AX=VAX/A
        AY=VAY/A
        AZ=VAZ/A
        E3X=AZ*DICOS(2,1,I)-AY*DICOS(3,1,I)
        E3Y=AX*DICOS(3,1,I)-AZ*DICOS(1,1,I)
        E3Z=AY*DICOS(1,1,I)-AX*DICOS(2,1,I)
        ANORM=DSQRT(E3X*E3X+E3Y*E3Y+E3Z*E3Z)
        DICOS(1,3,I)=E3X/ANORM
        DICOS(2,3,I)=E3Y/ANORM
        DICOS(3,3,I)=E3Z/ANORM
C
C....  ESTABLISH LOCAL-GLOBAL DIRECTION COSINE MATRIX
C
        DICOS(1,2,I)=DICOS(2,3,I)*DICOS(3,1,I)-
     1           DICOS(3,3,I)*DICOS(2,1,I)
        DICOS(2,2,I)=DICOS(3,3,I)*DICOS(1,1,I)-
     1           DICOS(1,3,I)*DICOS(3,1,I)
        DICOS(3,2,I)=DICOS(1,3,I)*DICOS(2,1,I)-
     1           DICOS(2,3,I)*DICOS(1,1,I)
       END IF
      END IF
C
C.... WRITE(6,99) I,((DICOS(LR,LC,I),LC=1,3),LR=1,3)
C
C
C.... MASS ASSEMBLY
C.... FOR BEAM ELEMENTS ONLY (TYPE=2)  CALCULATE AND ASSEBMLE ELEMENT
C.... MASS
C
      IF (IX(10,I).NE.2) RETURN
      MTYP=IX(9,I)
      RHO=E(1,MTYP)
      IF (RHO.EQ.0.) RETURN
      RT=RHO*AL(I)*E(7,MTYP)/2.D0
      RY=RT*AL(I)*AL(I)/12.D0
      RZ=RY
C
C.... RX - MASS MOMENT OF INERTIA ABOUT LOCAL X AXIS IS APPROXIMATE
C.... RX=RT*(E(5,MTYP)*E(5,MTYP) + E(8,MTYP)*E(8,MTYP))/12.D0
C
      RX=RT*2.D0*E(7,MTYP)/12.D0
```

```
C
C.... ASSEMBLE TRANSLATIONAL MASS
C
      DO N=3,4
       KK=IX(N,I)
       NN=(KK-1)*NDGREE
       DO M=1,3
        SMASS(NN+M)=RT+SMASS(NN+M)
       END DO
      END DO
C
C.... ASSEMBLE ROTATIONAL MASS IN GLOBAL COORDINATES
C
      DO M=3,4
       N=IX(M,I)
       DO II=1,3
        DO JJ=1,3
         RMASS(II,JJ,N)=RMASS(II,JJ,N)+DICOS(II,1,I)*DICOS(JJ,1,I)*RX
     1              +DICOS(II,2,I)*DICOS(JJ,2,I)*RY+
     2               DICOS(II,3,I)*DICOS(JJ,3,I)*RZ
        END DO
       END DO
      END DO
      RETURN
C
      END
```

```
      SUBROUTINE BFRCIN (L,ND,XC,YC,ZC,IX,E,UD,FINT,STRS,STRAIN,STRESS,N
     1UMEL,IPT,INDEX,SMASS,EUI,EUJ,TRAI,TRAJ,EH,AL,IEIGEN,INMESH)
C
Cbrc
Cbrc  REPLACED COMMON WITH INCLUDE AND GOTO WITH BLOCK IF AND DO
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... ROUTINE CALCULATES INTERNAL FORCES FOR THREE-D BEAM
C.... TRAI AND TRAJ CONTAIN I BAR 0 ,J BAR 0 AND J HAT 0 FOR NODES I & J
C
      INCLUDE 'ADJUST.COM'
      COMMON /MATRIX/ NAM,NB,NR
      INCLUDE 'NUMINT.COM'
      DOUBLE PRECISION  FINT(NFINT)

      DIMENSION XC(NXC), YC(NYC), IX(14,NIX), UD(NX1), E(12,NE),
     1        STRAIN(NSTRAI), SMASS(NSMASS), STRESS(NSTRES),
     2        STRS(NSTRS), INDEX(NINDEX), ZC(NZC), EUI(9), EUJ(9),
     3        EH(9), TRAI(12), TRAJ(12), AL(NAL), EJBI(3), EJBJ(3),
     4        TEMP1(3), TEMP2(3), TEMP3(3), TEMP4(3), TEMP5(3),
     5        OMEGI(3,3), OMEGJ(3,3), DISP(2), ROT(6), AFORCE(6),
     6        BMOMT(6), IPT(NIPT), INMESH(NINMEH)
      N1=IX(1,L)
      N2=IX(2,L)
      N3=IX(3,L)
      N4=IX(4,L)
C
C.... CHECK FOR PRIMARY OR SECONDARY NODES
C
      ISKIP=0
      JSKIP=0
      IF (N1.EQ.N3) ISKIP=1
      IF (N2.EQ.N4) JSKIP=1
C
      XX=XC(N2)-XC(N1)
      YY=YC(N2)-YC(N1)
      ZZ=ZC(N2)-ZC(N1)
      N1N=(N1-1)*ND
      N2N=(N2-1)*ND
      N3N=(N3-1)*ND
      N4N=(N4-1)*ND
      II=N1
      JJ=N2

      IF (ISKIP.EQ.1) THEN
       DIX=UD(N3N+1)
       DIY=UD(N3N+2)
       DIZ=UD(N3N+3)
      ELSE
       OMEGI(1,1)=0.D0
       OMEGI(1,2)=TRAI(12)
       OMEGI(1,3)=-TRAI(11)
       OMEGI(2,1)=-TRAI(12)
       OMEGI(2,2)=0.D0
       OMEGI(2,3)=TRAI(10)
       OMEGI(3,1)=TRAI(11)
       OMEGI(3,2)=-TRAI(10)
       OMEGI(3,3)=0.D0
       TEMP1(1)=TRAI(10)
       TEMP1(2)=TRAI(11)
       TEMP1(3)=TRAI(12)
       NAM = 3*3
       NB = 3*1
       NR = 3*1
       CALL GMPRD (EUI,TEMP1,TEMP3,3,3,1)
       DIX=UD(N3N+1)+TEMP3(1)-TRAI(7)
       DIY=UD(N3N+2)+TEMP3(2)-TRAI(8)
       DIZ=UD(N3N+3)+TEMP3(3)-TRAI(9)
       UD(N1N+1)=DIX
       UD(N1N+2)=DIY
       UD(N1N+3)=DIZ
      END IF

      IF (JSKIP.EQ.1) THEN
       DJX=UD(N4N+1)
```

```
      DJY=UD(N4N+2)
      DJZ=UD(N4N+3)
     ELSE
      OMEGJ(1,1)=0.D0
      OMEGJ(1,2)=TRAJ(12)
      OMEGJ(1,3)=-TRAJ(11)
      OMEGJ(2,1)=-TRAJ(12)
      OMEGJ(2,2)=0.D0
      OMEGJ(2,3)=TRAJ(10)
      OMEGJ(3,1)=TRAJ(11)
      OMEGJ(3,2)=-TRAJ(10)
      OMEGJ(3,3)=0.D0
      TEMP2(1)=TRAJ(10)
      TEMP2(2)=TRAJ(11)
      TEMP2(3)=TRAJ(12)
      CALL GMPRD (EUJ,TEMP2,TEMP4,3,3,1)
      DJX=UD(N4N+1)+TEMP4(1)-TRAJ(7)
      DJY=UD(N4N+2)+TEMP4(2)-TRAJ(8)
      DJZ=UD(N4N+3)+TEMP4(3)-TRAJ(9)
      UD(N2N+1)=DJX
      UD(N2N+2)=DJY
      UD(N2N+3)=DJZ
     END IF

     IF (IEIGEN.EQ.1) RETURN
C
C.... FIND RIDID BODY ROTATION AFTER DEFORMATION W/T ORIGINAL COORDINAT
C.... FIND STRAINS AT NODES, HT IS THICKNESS OF BEAM ELEMENT
C
     DIJX=DJX-DIX
     DIJY=DJY-DIY
     DIJZ=DJZ-DIZ
     DX=XX+DIJX
     DY=YY+DIJY
     DZ=ZZ+DIJZ
     AL2=AL(L)*AL(L)
C
C.... FAC = CENTROIDAL AXIS STRAIN
C
     FAC=2.D0*(XX*DIJX+YY*DIJY+ZZ*DIJZ)+DIJX*DIJX+DIJY*DIJY+DIJZ*DIJZ
     ALN2=AL2+FAC
     ALN=DSQRT(ALN2)
     IFLAG=0

     IF (IFLAG.NE.0) THEN
      WRITE (6,901) L,AL(L),ALN
      WRITE (6,902) DIX,DIY,DIZ,DJX,DJY,DJZ
      WRITE (6,903) XX,YY,ZZ,DX,DY,DZ
     END IF
C
C.... EH IS NEW POSITION OF LOCAL AXIS
C
     EH(1)=DX/ALN
     EH(2)=DY/ALN
     EH(3)=DZ/ALN

     DO I=1,3
      I4=3+I
      I3=6+I
      EJBI(I)=EUI(I)*TRAI(4)+EUI(I4)*TRAI(5)+EUI(I3)*TRAI(6)
      EJBJ(I)=EUJ(I)*TRAJ(4)+EUJ(I4)*TRAJ(5)+EUJ(I3)*TRAJ(6)
     END DO

     DO I=1,3
      I4=3+I
      EH(I4)=(EJBI(I)+EJBJ(I))/2.D0
     END DO

     EH(7)=EH(2)*EH(6)-EH(3)*EH(5)
     EH(8)=EH(3)*EH(4)-EH(1)*EH(6)
     EH(9)=EH(1)*EH(5)-EH(2)*EH(4)
     ENORM=DSQRT(EH(7)*EH(7)+EH(8)*EH(8)+EH(9)*EH(9))
     EH(7)=EH(7)/ENORM
     EH(8)=EH(8)/ENORM
     EH(9)=EH(9)/ENORM
     EH(4)=EH(8)*EH(3)-EH(9)*EH(2)
```

```
      EH(5)=EH(9)*EH(1)-EH(7)*EH(3)
      EH(6)=EH(7)*EH(2)-EH(8)*EH(1)
C
C.... DETERMINE DEFORMATION ROTATIONS OF BEAM
C.... EH CONTAINS MU,    EUI & EUJ CONTAIN LAMDA I & LAMDA J
C.... CALCULATE DEFORMATION ROTATIONS LOCAL  COORDINATES(PHIY,PHIZ ECT.)
C
      ROT(1)=(EJBI(2)*EJBJ(3)-EJBI(3)*EJBJ(2))*EH(1)
      ROT(1)=ROT(1)+(EJBI(1)*EJBJ(3)-EJBI(3)*EJBJ(1))*EH(2)
      ROT(1)=ROT(1)+(EJBI(1)*EJBJ(2)-EJBI(2)*EJBJ(1))*EH(3)
      ROT(3)=-(EH(7)*EUI(1)+EH(8)*EUI(2)+EH(9)*EUI(3))*TRAI(1)
      ROT(3)=ROT(3)-(EH(7)*EUI(4)+EH(8)*EUI(5)+EH(9)*EUI(6))*TRAI(2)
      ROT(3)=ROT(3)-(EH(7)*EUI(7)+EH(8)*EUI(8)+EH(9)*EUI(9))*TRAI(3)
      ROT(5)=(EH(4)*EUI(1)+EH(5)*EUI(2)+EH(6)*EUI(3))*TRAI(1)
      ROT(5)=ROT(5)+(EH(4)*EUI(4)+EH(5)*EUI(5)+EH(6)*EUI(6))*TRAI(2)
      ROT(5)=ROT(5)+(EH(4)*EUI(7)+EH(5)*EUI(8)+EH(6)*EUI(9))*TRAI(3)
      ROT(4)=-(EH(7)*EUJ(1)+EH(8)*EUJ(2)+EH(9)*EUJ(3))*TRAJ(1)
      ROT(4)=ROT(4)-(EH(7)*EUJ(4)+EH(8)*EUJ(5)+EH(9)*EUJ(6))*TRAJ(2)
      ROT(4)=ROT(4)-(EH(7)*EUJ(7)+EH(8)*EUJ(8)+EH(9)*EUJ(9))*TRAJ(3)
      ROT(6)=(EH(4)*EUJ(1)+EH(5)*EUJ(2)+EH(6)*EUJ(3))*TRAJ(1)
      ROT(6)=ROT(6)+(EH(4)*EUJ(4)+EH(5)*EUJ(5)+EH(6)*EUJ(6))*TRAJ(2)
      ROT(6)=ROT(6)+(EH(4)*EUJ(7)+EH(5)*EUJ(8)+EH(6)*EUJ(9))*TRAJ(3)
C
      IF (IFLAG.NE.0) THEN
       WRITE (6,904) L,(ROT(LL),LL=3,6)
       WRITE (6,905) (EH(LL),LL=1,9)
       WRITE (6,906) (EUI(LL),LL=1,9)
       WRITE (6,907) (EUJ(LL),LL=1,9)
       WRITE (6,908) (TRAI(LL),LL=1,3)
       WRITE (6,909) (TRAJ(LL),LL=1,3)
      END IF
C
C.... CHECK FOR LARGE ROTATIONS
C
      DO KK=3,6
       IF(DABS(ROT(KK)).GE.0.15) ROT(KK)=DASIN(ROT(KK))
      END DO
C
C.... DETERMINE LOCAL INTERNAL FORCES
C
      STREH=FAC/(AL(L)+ALN)/AL(L)
      MTYP=IX(9,L)
      DISP(1)=ALN
      DISP(2)=STREH
      NOPT=IX(10,L)
      I1=1
      ISEC=IX(11,L)
      IF (ISEC.NE.0) I1=IPT(ISEC)
      CALL LOCFRC (L,DISP,ROT,AFORCE,BMOMT,E,INDEX,I1,STRAIN,STRESS,
     1          STRS,SMASS,IX,AL(L),MTYP,NOPT,NUMEL,ZC,INMESH)
C
C....  ACCUMULATE INTERNAL ELEMENTAL FORCES TO  FINT
C....  COMPUTE GLOBAL COMPONENTS OF FINT
C
      TEMP1(1)=AFORCE(1)
      TEMP1(2)=AFORCE(3)
      TEMP1(3)=AFORCE(5)
      NAM = 3*3
      NB = 3*1
      NR = 3*1
      CALL GMPRD (EH,TEMP1,TEMP2,3,3,1)
      TEMP3(1)=AFORCE(2)
      TEMP3(2)=AFORCE(4)
      TEMP3(3)=AFORCE(6)
      CALL GMPRD (EH,TEMP3,TEMP1,3,3,1)

      DO I=1,3
       FINT(N3N+I)=FINT(N3N+I)+TEMP2(I)
       FINT(N4N+I)=FINT(N4N+I)+TEMP1(I)
      END DO

      IF (ISKIP.EQ.1) THEN
       DO I=1,3
        TEMP2(I)=0.D0
       END DO
      ELSE
```

```
      CALL GTPRD (EUI,TEMP2,TEMP3,3,3,1)
      CALL GTPRD (OMEGI,TEMP3,TEMP2,3,3,1)
     END IF

     IF (JSKIP.EQ.1) THEN
      DO I=1,3
       TEMP1(I)=0.D0
      END DO
     ELSE
      CALL GTPRD (EUJ,TEMP1,TEMP3,3,3,1)
      CALL GTPRD (OMEGJ,TEMP3,TEMP1,3,3,1)
     END IF

     TEMP4(1)=BMOMT(1)
     TEMP4(2)=BMOMT(3)
     TEMP4(3)=BMOMT(5)
     TEMP5(1)=BMOMT(2)
     TEMP5(2)=BMOMT(4)
     TEMP5(3)=BMOMT(6)
     CALL GMPRD (EH,TEMP4,TEMP3,3,3,1)
     CALL GTPRD (EUI,TEMP3,TEMP4,3,3,1)
     CALL GMPRD (EH,TEMP5,TEMP3,3,3,1)
     CALL GTPRD (EUJ,TEMP3,TEMP5,3,3,1)
     I=0

     DO J=4,6
      I=I+1
      FINT(N3N+J)=FINT(N3N+J)+TEMP4(I)+TEMP2(I)
      FINT(N4N+J)=FINT(N4N+J)+TEMP5(I)+TEMP1(I)
     END DO

     RETURN
C
 901 FORMAT (2X,5HEL NO,I5,2X,7HL0 + LN,1P2D20.4)
 902 FORMAT (2X,7HDI + DJ,/,5X,1P6D20.4)
 903 FORMAT (3X,7HXX + DX,/,5X,1P6D20.4)
 904 FORMAT (5X,3HEL=,I5,/,5X,3HROT,1P4D20.4)
 905 FORMAT (5X,2HEH,/,3(5X,1P3D20.4,/))
 906 FORMAT (5X,3HEUI,/,3(5X,1P3D20.4,/))
 907 FORMAT (5X,3HEUJ,/,3(5X,1P3D20.4,/))
 908 FORMAT (5X,4HTRAI,1P3D20.4)
 909 FORMAT (5X,4HTRAJ,1P3D20.4)
     END
```

```
      SUBROUTINE CROSS (A,B,C,BETA,CMAG,IS)
C
Cbrc
Cbrc  CLEANED UP SOME CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      DIMENSION A(3), B(3), C(3)
C
C.... PROGRAM FORMS CROSS PRODUCT
C.... AND ANGLE BETA.  C NORMED TO CMAG
C....    C = A X B
C
      C(1)=A(2)*B(3)-A(3)*B(2)
      C(2)=A(3)*B(1)-A(1)*B(3)
      C(3)=A(1)*B(2)-A(2)*B(1)
      AMAG=0.D0
      BMAG=0.D0
      CMAG=0.D0

      DO I=1,3
       AMAG=AMAG+A(I)*A(I)
       BMAG=BMAG+B(I)*B(I)
       CMAG=CMAG+C(I)*C(I)
      END DO

      AMAG=DSQRT(AMAG)
      BMAG=DSQRT(BMAG)
      CMAG=DSQRT(CMAG)
      BETA=CMAG/(AMAG*BMAG)
      IF (DABS(BETA).GT.1.) RETURN
      BETA=DASIN(BETA)
      IF (IS.EQ.1) RETURN

      DO I=1,3
       C(I)=C(I)/CMAG
      END DO

      RETURN
      END
```

```
      SUBROUTINE DECOD (NUM,JJ,NBASE,NTERMS)
C
Cbrc
Cbrc  CLEANED UP SOME CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      DIMENSION JJ(NTERMS)
C
C.... NUM = NUMBER TO BE DECODED
C.... JJ = RETURNS DECODED TERMS IN NUM  1 TO NTERMS
C.... NBASE = BASE WHICH NUM IS CODED IN
C.... JJ(NTERMS) = NODE NUMBER
C
      ND=NUM
      N=NTERMS-1
      J=NBASE**N
      JJ(NTERMS)=ND/J
      ND=ND-JJ(NTERMS)*J

      DO K=1,N
       J=NBASE**(N-K)
       JJ(K)=ND/J
       ND=ND-JJ(K)*J
      END DO

      RETURN
      END
```

```
      SUBROUTINE EIGEN (A,R,N,MV)
C
Cbrc
Cbrc  CLEANED UP SOME CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      COMMON /NEIGEN/ NA,NR
      DIMENSION A(NA), R(NR)
      RANGE=1.0D-7

      IF ((MV-1).NE.0) THEN
       IQ=-N

       DO J=1,N
        IQ=IQ+N
        DO I=1,N
         IJ=IQ+I
         R(IJ)=0.D0
         IF ((I-J).NE.0) CYCLE
         R(IJ)=1.D0
        END DO
       END DO
      END IF

      ANORM=0.D0

      DO I=1,N
       DO J=1,N
        IF ((I-J).EQ.0) CYCLE
        IA=I+(J*J-J)/2
        ANORM=ANORM+A(IA)*A(IA)
       END DO
      END DO

      IF (ANORM.GT.0) THEN
       ANORM=DSQRT(2.D0)*DSQRT(ANORM)
       ANRMX=ANORM*RANGE/FLOAT(N)
       IND=0
       THR=ANORM
   9   THR=THR/FLOAT(N)
  10   L=1
  11   M=L+1
  12   MQ=(M*M-M)/2
       LQ=(L*L-L)/2
       LM=L+MQ
       IF (DABS(A(LM)).GE.THR) THEN
        IND=1
        LL=L+LQ
        MM=M+MQ
        X=.5D0*(A(LL)-A(MM))
        Y=-A(LM)/DSQRT(A(LM)*A(LM)+X*X)
        IF (X.LT.0) Y=-Y
        SINX=Y/DSQRT(2.D0*(1.D0+(DSQRT(1.D0-Y*Y))))
        SINX2=SINX*SINX
        COSX=DSQRT(1.D0-SINX2)
        COSX2=COSX*COSX
        SINCS=SINX*COSX
        ILQ=N*(L-1)
        IMQ=N*(M-1)

        DO I=1,N
         IQ=(I*I-I)/2
         IF (I.NE.L) THEN

          IF (I.LT.M) THEN
           IM=I+MQ
          ELSE IF (I.GT.M) THEN
           IM=M+IQ
          ELSE
           IF ((MV-1).EQ.0) CYCLE
           ILR=ILQ+I
           IMR=IMQ+I
           X=R(ILR)*COSX-R(IMR)*SINX
           R(IMR)=R(ILR)*SINX+R(IMR)*COSX
           R(ILR)=X
```

```
      END IF

      IF (I.LT.L) THEN
       IL=I+LQ
      ELSE
       IL=L+IQ
      END IF

      X=A(IL)*COSX-A(IM)*SINX
      A(IM)=A(IL)*SINX+A(IM)*COSX
      A(IL)=X
     END IF

     IF ((MV-1).EQ.0) CYCLE
     ILR=ILQ+I
     IMR=IMQ+I
     X=R(ILR)*COSX-R(IMR)*SINX
     R(IMR)=R(ILR)*SINX+R(IMR)*COSX
     R(ILR)=X
    END DO

    X=2.D0*A(LM)*SINCS
    Y=A(LL)*COSX2+A(MM)*SINX2-X
    X=A(LL)*SINX2+A(MM)*COSX2+X
    A(LM)=(A(LL)-A(MM))*SINCS+A(LM)*(COSX2-SINX2)
    A(LL)=Y
    A(MM)=X
   END IF

   IF (M.NE.N) THEN
    M=M+1
    GO TO 12
   END IF

   IF (L.NE.(N-1)) THEN
    L=L+1
    GO TO 11
   END IF

   IF (IND.EQ.1) THEN
    IND=0
    GO TO 10
   END IF

   IF (THR.GT.ANRMX) GO TO 9
  END IF

  IQ=-N

  DO I=1,N
   IQ=IQ+N
   LL=I+(I*I-I)/2
   JQ=N*(I-2)

   DO J=I,N
    JQ=JQ+N
    MM=J+(J*J-J)/2
    IF (A(LL).GE.A(MM)) CYCLE
    X=A(LL)
    A(LL)=A(MM)
    A(MM)=X
    IF (MV.EQ.1) CYCLE

    DO K=1,N
     ILR=IQ+K
     IMR=JQ+K
     X=R(ILR)
     R(ILR)=R(IMR)
     R(IMR)=X
    END DO
   END DO
  END DO

  RETURN
  END
  SUBROUTINE ELOUT (STRS,IX,INDEX,NUMEL,IPTS)
```

```
C
Cbrc
Cbrc  CLEANED UP CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      DIMENSION STRS(NSTRS), IX(14,NIX), INDEX(NINDEX), IPTS(NIPT)

      WRITE (6,901)
      CON1=4.448D5
      CON2=.394D0
      CON3=CON2/CON1
      CON4=CON2**3
      IFLAG=0
      IPLATE=0

      DO JE=1,NUMEL
       NOPT=IX(10,JE)
       IND=INDEX(JE)
       IF (NOPT.EQ.1) THEN
        N=IND+14
        WRITE (6,902) JE,STRS(N)
        STRS(N)=STRS(N)/CON1
        WRITE (6,903) STRS(N)
        STRS(N)=STRS(N)*CON1
       ELSE IF (NOPT.EQ.2 .OR. NOPT.EQ.3) THEN
        IF (NOPT.EQ.2) THEN
         N=IND+26
         IF (IX(11,JE).NE.0) IFLAG=IX(11,JE)
        ELSE IF (NOPT.EQ.3) THEN
         N=IND+24
        END IF
        NEND=N+7
        WRITE (6,904) JE,(STRS(K),K=N,NEND)
        DO K=1,3
         I=K-1
         STRS(N+I)=STRS(N+I)/CON1
        END DO
        DO K=4,8
         I=K-1
         STRS(N+I)=STRS(N+I)*CON3
        END DO
        WRITE (6,905) (STRS(K),K=N,NEND)
        DO K=1,3
         I=K-1
         STRS(N+I)=STRS(N+I)*CON1
        END DO
        DO K=4,8
         I=K-1
         STRS(N+I)=STRS(N+I)/CON3
        END DO
       ELSE IF (NOPT.EQ.4) THEN
        N=IND+36
        WRITE (6,906) JE,STRS(N),STRS(N+1),STRS(N+3)
        STRS(N)=STRS(N)/(CON1*CON2*CON2)
        STRS(N+1)=STRS(N+1)*CON4
        STRS(N+3)=STRS(N+3)/CON1
        WRITE (6,907) STRS(N),STRS(N+1),STRS(N+3)
        STRS(N)=STRS(N)*CON1*CON2*CON2
        STRS(N+1)=STRS(N+1)/CON4
        STRS(N+3)=STRS(N+3)*CON1
       ELSE IF (NOPT.EQ.5) THEN
        IPLATE=1
       END IF
      END DO

      IF (IFLAG.NE.0) THEN
       WRITE (6,908)
       DO I=1,NUMEL
        IF (IX(10,I).EQ.5) CYCLE
        ISEC=IX(11,I)
        I1=1
        IF (ISEC.NE.0) I1=IPTS(ISEC)
        WRITE (6,909) I
        IF (I1.EQ.1) THEN
```

```
        IND=INDEX(I)+24
        WRITE (6,911) STRS(IND),STRS(IND+1)
        CYCLE
       END IF
       IND=INDEX(I)+41
       DO K=1,2
        WRITE (6,910) K
        DO M=1,I1
         N1=IND+M-1+(K-1)*I1
         N2=2*I1+N1
         N3=4*I1+N1
         WRITE (6,911) STRS(N1),STRS(N2),STRS(N3)
        END DO
       END DO
      END DO
     END IF

     IF (IPLATE.EQ.0) RETURN
     WRITE (6,912)

     DO I=1,NUMEL
      IP=IX(11,I)
      IND=INDEX(I)-1
      WRITE (6,913) I
      DO KP=1,IP
       WRITE (6,914) KP
       DO IS=1,3
        NN=IS+3
        N1=IND+30+3*(7*(KP-1)+IS-1)+1
        N2=N1+9
        N3=N2+9-2*(IS-1)
        WRITE (6,915) NN,STRS(N1),STRS(N1+1),STRS(N1+2),STRS(N2),
    1               STRS(N2+1),STRS(N2+2),STRS(N3)
       END DO
      END DO
     END DO

     RETURN
C
 901 FORMAT (10X,20HLOCAL ELEMENT FORCES,/,/,5X,11HELEMENT NO.,6X,7H(UN
    1ITS),7X,11HAXIAL FORCE,10X,9HY - SHEAR,10X,9HZ - SHEAR,10X,10HX -
    2MOMENT,/,36X,11HYI - MOMENT,10X,11HYJ - MOMENT,8X,11HZI - MOMENT,8
    3X,11HZJ - MOMENT,//)
 902 FORMAT (5X,I5,11X,9H(DYNE-CM),G16.6,/)
 903 FORMAT (21X,8H(LBF-IN),1X,G16.6,//)
 904 FORMAT (5X,I5,11X,9H(DYNE-CM),4(G16.6,5X),/,30X,4(G16.6,5X),/)
 905 FORMAT (21X,8H(LBF-IN),1X,4(G16.6,5X),/,30X,4(G16.6,5X),//)
 906 FORMAT (5X,I5,11X,9H(DYNE-CM),5X,10HPRESSURE =,1PD12.4,5X,8HVOLUME
    1 =,1PD12.4,5X,7HFORCE 1,1PD12.4,/)
 907 FORMAT (21X,8H(LBF-IN),6X,10HPRESSURE =,1PD12.4,5X,8HVOLUME =,1PD1
    12.4,5X,7HFORCE =,1PD12.4,/)
 908 FORMAT (1H1,6X,11HELEMENT NO.,18X,7HSECTION,6X,6HSTRAIN,19X,6HSTRE
    1SS,16X,12HYIELD STRESS)
 909 FORMAT (12X,I5)
 910 FORMAT (35X,I5)
 911 FORMAT (36X,3(5X,1PD20.4))
 912 FORMAT (1H1,9X,33HSTRAINS,STRESSES AND YIELD VALUES//1X,7HELEMENT/
    16X,5HLAYER,9X,5HEPS-X,8X,5HEPS-Y,8X,6HEPS-XY,7X,5HSTR-X,8X,5HSTR-Y
    2,8X,6HSTR-XY,6X,5HYIELD/,10X,5HPOINT)
 913 FORMAT (I5,I4)
 914 FORMAT (5X,I4)
 915 FORMAT (10X,I3,2X,1P7D13.5)
     END
```

```
      SUBROUTINE FRCIN (NUMEL,NDGREE,XC,YC,ZC,IX,E,UD,FINT,STRS,ST
     1RAIN,STRESS,IPTS,INDEX,BLAMB,SMASS,DICOS,NPRI,AL,IEIGEN,INMESH)
Cbrc
Cbrc  CLEANED UP CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      DOUBLE PRECISION FINT(NFINT)

      INCLUDE 'ADJUST.COM'
      DIMENSION XC(NXC), YC(NYC), ZC(NZC), IX(14,NIX), E(12,NE), UD(
     1      NX1), STRS(NSTRS), DICOS(9,NDICOS), STRAIN(NSTRAI),
     2      STRESS(NSTRES), INDEX(NINDEX), BLAMB(NNBLAM), SMASS(
     3      NSMASS), AL(NAL), IPTS(NIPT), INMESH(NINMEH)
C
C.... THIS SUBROUTINE CALCULATES THE INTERNAL FORCES IN ALL OF THE
C.... ELEMENTS AND RETURNS THEM IN  FINT
C
      IF (IEIGEN.NE.1) THEN
       NEQ=NPRI*NDGREE
       ISTIF=0
C
C.... ZERO OUT FINT ARRAY
C
       DO LEN=1,NEQ
        FINT(LEN)=0.D0
       END DO
      END IF
C
C.... SET UP LOCAL ARRAY ENTRIES FOR  BFRCIN  AND  SFRCIN
C
C
      DO JE=1,NUMEL
       NOPT=IX(10,JE)
       NP1=3
       IF (NOPT.EQ.4) NP1=7
       IF (NOPT.EQ.5) NP1=4
       I=(IX(NP1,JE)-1)*9+1
       J=(IX(NP1+1,JE)-1)*9+1
       K=(IX(NP1+2,JE)-1)*9+1
       M=INDEX(JE)
       MB=M+12
       MS=M+6
       MPV=M+18
       MPL2=M+9
       MPL3=MPL2+9
       MPSIDE=M+27
       IF (NOPT.EQ.1) THEN
        CALL SFRCIN (JE,NDGREE,XC,YC,ZC,IX,E,UD,FINT,STRS,STRAIN,
     1         STRESS,NUMEL,INDEX,SMASS,BLAMB(I),BLAMB(J),
     2         STRS(M),STRS(MS),DICOS(1,JE),AL,IEIGEN,
     3         INMESH)
       ELSE IF (NOPT.EQ.2 .OR. NOPT.EQ.3) THEN
        CALL BFRCIN (JE,NDGREE,XC,YC,ZC,IX,E,UD,FINT,STRS,STRAIN,
     1         STRESS,NUMEL,IPTS,INDEX,SMASS,BLAMB(I),BLAMB(J),
     2         STRS(M),STRS(MB),DICOS(1,JE),AL,IEIGEN,INMESH)
       ELSE
        CYCLE
       END IF
      END DO

      RETURN
      END
```

```
      SUBROUTINE FREEFD(KONWAV,NUMDIS,NODDIS,NNODE,NDGREE,XC,YC,ZC,
     1            UD,UD1,UD2,FORCD,INMESH,BETA )

      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      INCLUDE 'ADJUST.COM'
      INCLUDE 'DYNAM.COM'
      DIMENSION UD(1),UD1(1),UD2(1),FORCD(1),NODDIS(1),INMESH(1)
C
C
C FREEFD FOR HYBRID II PENDULUM TEST.  INITIAL VELOCITY = 19.5 ft/sec AT WAND
C PRESCRIBED ACCELERATION PROFILE CONSISTS OF
C    "HALF-SINE"     FOR  0.LE.T.LT.T1
C    "1-COS+CONSTANT" FOR T1.LE.T.LT.T2
C    "A CONSTANT"    FOR T2.LE.T
C
C    V0 IS THE INITIAL X-VELOCITY OF BASE POINT
                         ==> FLEXION <==
C
Cbrc
Cbrc  INITIALIZE VARIABLES IF THE FIRST TIME STEP
Cbrc
      IF (TIME .LT. DELT) THEN
       G = 980.66352D0
       VO = 658.1
       NCGTX = 6*(INMESH(4)-1)+1
       NPNTX = 6*(INMESH(1)-1)+1
       UD1(NCGTX) = 710.5
       CALL ICIF(TIME,DUMMY,2)
       RETURN
      END IF

      CALL ICIF(TIME,ACC,0)
      CALL ICIF(TIME,VEL,1)
      CALL ICIF(TIME,DIS,2)
      UD (NPNTX) = DIS*G + VO*TIME
      UD1(NPNTX) = VEL*G + VO
      UD2(NPNTX) = ACC*G

      RETURN
      END
```

```
      SUBROUTINE GMPRD (A,B,R,N,M,L)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... ..................................................................
C....   SUBROUTINE GMPRD
C....   PURPOSE
C....      MULTIPLY TWO GENERAL MATRICES TO FORM A RESULTANT GENERAL
C....      MATRIX
C....   USAGE
C....      CALL GMPRD(A,B,R,N,M,L)
C....   DESCRIPTION OF PARAMETERS
C....      A - NAME OF FIRST INPUT MATRIX
C....      B - NAME OF SECOND INPUT MATRIX
C....      R - NAME OF OUTPUT MATRIX
C....      N - NUMBER OF ROWS IN A
C....      M - NUMBER OF COLUMNS IN A AND ROWS IN B
C....      L - NUMBER OF COLUMNS IN B
C....   REMARKS
C....      ALL MATRICES MUST BE STORED AS GENERAL MATRICES
C....      MATRIX R CANNOT BE IN THE SAME LOCATION AS MATRIX A
C....      MATRIX R CANNOT BE IN THE SAME LOCATION AS MATRIX B
C....      NUMBER OF COLUMNS OF MATRIX A MUST BE EQUAL TO NUMBER OF ROW
C....      OF MATRIX B
C....   SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C....      NONE
C....   METHOD
C....      THE M BY L MATRIX B IS PREMULTIPLIED BY THE N BY M MATRIX A
C....      AND THE RESULT IS STORED IN THE N BY L MATRIX R.
C.... ..................................................................
C
      COMMON /MATRIX/ NA,NB,NR
      DIMENSION A(NA), B(NB), R(NR)
C
      IR=0
      IK=-M
      DO 1 K=1,L
       IK=IK+M
       DO 1 J=1,N
       IR=IR+1
       JI=J-N
       IB=IK
       R(IR)=0
       DO 1 I=1,M
       JI=JI+N
       IB=IB+1
    1  R(IR)=R(IR)+A(JI)*B(IB)
      RETURN
      END
```

```
      SUBROUTINE GTPRD (A,B,R,N,M,L)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... ..................................................................
C....   SUBROUTINE GTPRD
C....   PURPOSE
C....     PREMULTIPLY A GENERAL MATRIX BY THE TRANSPOSE OF ANOTHER
C....     GENERAL MATRIX
C....   USAGE
C....     CALL GTPRD(A,B,R,N,M,L)
C....   DESCRIPTION OF PARAMETERS
C....     A - NAME OF FIRST INPUT MATRIX
C....     B - NAME OF SECOND INPUT MATRIX
C....     R - NAME OF OUTPUT MATRIX
C....     N - NUMBER OF ROWS IN A AND B
C....     M - NUMBER OF COLUMNS IN A AND ROWS IN R
C....     L - NUMBER OF COLUMNS IN B AND R
C....   REMARKS
C....     MATRIX R CANNOT BE IN THE SAME LOCATION AS MATRIX A
C....     MATRIX R CANNOT BE IN THE SAME LOCATION AS MATRIX B
C....     ALL MATRICES MUST BE STORED AS GENERAL MATRICES
C....   SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED
C....     NONE
C....   METHOD
C....     MATRIX TRANSPOSE OF A IS NOT ACTUALLY CALCULATED. INSTEAD,
C....     ELEMENTS OF MATRIX A ARE TAKEN COLUMNWISE RATHER THAN
C....     ROWWISE FOR POSTMULTIPLICATION BY MATRIX B.
C.... ..................................................................
C
      COMMON /MATRIX/ NA,NB,NR
      DIMENSION A(NA), B(NB), R(NR)
C
      IR=0
      IK=-N
      DO 1 K=1,L
       IJ=0
       IK=IK+N
       DO 1 J=1,M
       IB=IK
       IR=IR+1
       R(IR)=0
       DO 1 I=1,N
       IJ=IJ+1
       IB=IB+1
    1  R(IR)=R(IR)+A(IJ)*B(IB)
      RETURN
      END
```

```
      SUBROUTINE ICIF (TIME,VALUE,NI)
Cbrc
Cbrc  CODE CLEAN-UP - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      DIMENSION T(26),F(26),FP(26),F1(25),F2(25)
      NJ=NI+1
C
C.... READ IN DATA AND INITIALIZE INTEGRATION ROUTINE
C

      IF (TIME .LE. 0.D0) THEN
       READ (5,901) NPTS,F1(1),F2(1)
       READ (5,902) (T(K),F(K),FP(K),K=1,NPTS)
       WRITE (6,903) NPTS,F1(1),F2(1)
       WRITE (6,904) (T(K),F(K),FP(K),K=1,NPTS)
       DO K=2,NPTS
        TK=T(K)
        CALL ICIF2 (TK,0.D0,2,NPTS,T,F,FP,F1,F2)
        F1(K)=0.D0
        CALL ICIF2 (TK,0.D0,3,NPTS,T,F,FP,F1,F2)
        F2(K)=0.D0
       END DO
      END IF

      CALL ICIF2 (TIME,VALUE,NJ,NPTS,T,F,FP,F1,F2)

      RETURN

  901 FORMAT (I5,5X,2D10.0)
  902 FORMAT (3D10.0)
  903 FORMAT (////,10X,26HNUMERICAL INTEGRATION DATA,//,5X,18HNO. OF POI
     1NTS    =,I5,/,5X,18HINITIAL VELOCITY =,1PD15.6,/,5X,18HINITIAL DIS
     2P     =,1PD15.6,/,15X,4HTIME,15X,9HFCN-VALUE,11X,14HFCN-DERIVATIVE
     3,/)
  904 FORMAT (5X,1P3D20.4,/)

      END
```

```
      SUBROUTINE ICIF2 (TIME,VALUE,NJ,NPTS,T,F,FP,F1,F2)
Cbrc
Cbrc  CODE CLEAN-UP - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      DIMENSION T(26),F(26),FP(26),F1(25),F2(25),G(4),PHI(4)
C
C.... DETERMINE INTERVAL NUMBER  IN
C
      IN=1
      DO K=2,NPTS
       IF (TIME .LE. T(K)) EXIT
       IN=IN+1
      END DO
C
C.... CHECK UPPER BOUND
C
      IF (IN.GE.NPTS) THEN
       WRITE (6,901) TIME,T(NPTS)
       IN=NPTS-1
      END IF
C
C.... SET UP FUNCTIONAL VALUES FOR APPROPRIATE INTERVAL
C
      TI=T(IN)
      TJ=T(IN+1)
      DT=TJ-TI

      G(1)=F(IN)
      G(2)=FP(IN)
      G(3)=F(IN+1)
      G(4)=FP(IN+1)
      X=TIME-TI
C
C.... TRANSFER TO APPROPRIATE NUMBER OF INTEGRATIONS
C
      IF (NJ.EQ.1) THEN
C
C.... FUNCTIONAL VALUE
C
       T1=1.D0
       XL=X/DT
       XL2=XL*XL
       XL3=XL*XL2
       CON=0.D0
      ELSE IF (NJ.EQ.2) THEN
C
C.... ONE INTEGRATION
C
       T1=X
       XL=X**2/(2.D0*DT)
       XL2=X**3/(3.D0*DT**2)
       XL3=X**4/(4.D0*DT**3)
       CON=F1(IN)
      ELSE IF (NJ.EQ.3) THEN
C
C.... TWO INTEGRATIONS
C
       T1=X**2/2.D0
       XL=X**3/(6.D0*DT)
       XL2=X**4/(12.D0*DT**2)
       XL3=X**5/(20.D0*DT**3)
       CON=X*F1(IN)+F2(IN)
      END IF
C
C.... EVALUATION OF APPROPRIATE FUNCTION
C
      PHI(1)=T1-3.D0*XL2+2.D0*XL3
      PHI(2)=(XL-2.D0*XL2+XL3)*DT
      PHI(3)=T1-PHI(1)
      PHI(4)=(XL3-XL2)*DT
      VALUE=CON
      DO K=1,4
       VALUE=VALUE+PHI(K)*G(K)
      END DO
```

```
      RETURN
C
 901 FORMAT (///,10X,34H WARNING - AN INTEGRATION POINT X=,D20.8,/,
     128X,35HIS GREATER THAN THE MAXIMUM VALUE =,D20.8,/,28X,69HIT IS
     2 ASSUMED THIS X IS IN THE LAST INTERVAL EXECUTION CONTINUING,//)

      END
```

```
      SUBROUTINE INCODE (NUM,JJ,NBASE,NTERMS)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
Cbrc
Cbrc  CODE CLEAN-UP - DJP
Cbrc
      DIMENSION JJ(NTERMS)
C
C.... NUM = RETURNS CODED NUMBER
C.... JJ = TERMS TO BE CODED INTO NUM  1 TO NTERMS
C.... NBASE = BASE USED TO CODE NUM
C
      NUM=0
      DO K=1,NTERMS
       NUM=NUM+JJ(K)*NBASE**(NTERMS-K)
      END DO
      RETURN
      END
```

```
      SUBROUTINE IODECLS(INP, OUT, PLT)
      INTEGER INP, OUT, PLT, LUTRM, LUIN, LUOUTP, LUPLT
      CHARACTER*1  ANS, QUOTE
      CHARACTER*64 NAINP,NAOUT,NAPLT
      CHARACTER*80 ITITLE
      LOGICAL IEXIST
      COMMON /DEVS/LUTRM, LUIN, LUOUTP, LUPLT
      COMMON /LABELS/NAINP,NAOUT,NAPLT
      QUOTE = '"'
      LUTRM = 0
      LUIN = 5
      LUOUTP = 6
      LUPLT = 7
C
C   TERMINAL:  LOGICAL UNIT 0
C      INPUT:  LOGICAL UNIT 1  (DATA FILE)
C     OUTPUT:  LOGICAL UNIT 2
C  PLOT FILE:  LOGICAL UNIT 3
C
      IEXIST =.FALSE.
      IF (INP .NE. 0) THEN
        WRITE(LUTRM,'(//,5X,"ENTER INPUT FILE NAME.")')
    5   READ(LUTRM,'(A64)') NAINP
        INQUIRE(FILE=NAINP,EXIST=IEXIST)
        IF (IEXIST) THEN
          OPEN(LUIN,FILE=NAINP,STATUS='OLD')
          WRITE(LUTRM,'(//,5X,"INPUT FILE NAME: ",A64)') NAINP
        ELSE
          WRITE(LUTRM,'(5X,"*** FILE NAME:  ",A64,/,5X,
     *     "NOT FOUND")')  NAINP
          WRITE(LUTRM,'(/,5X,"ENTER A NEW FILE NAME.")')
          GOTO 5
        END IF
      END IF
      IEXIST = .FALSE.
      IF (OUT .NE. 0) THEN
         WRITE(LUTRM,'(/,5X,"ENTER OUTPUT FILE NAME.")')
   10    READ(LUTRM,'(A64)') NAOUT
         INQUIRE(FILE=NAOUT,EXIST=IEXIST)
        IF(IEXIST) THEN
         WRITE(LUTRM,'(5X,"*** FILE NAME:  ",A64,/,5X,
     *   "ALREADY EXISTS.  DO YOU WISH TO OVERWRITE IT? (Y/N)")')
     *    NAOUT
         READ(LUTRM,'(A1)') ANS
         IF(ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
           OPEN(LUOUTP,FILE=NAOUT,IOSTAT=IERR,STATUS='OLD',
     *            BLOCKSIZE=2048)
           REWIND(UNIT=LUOUTP)
         ELSE
           WRITE(LUTRM,'(/,5X,"ENTER A NEW FILE NAME")')
           GOTO 10
         END IF
        ELSE
         OPEN(LUOUTP,FILE=NAOUT,IOSTAT=IERR,STATUS='NEW',
     *            BLOCKSIZE=2048)
        END IF
        WRITE(LUTRM,'(//,5X,"OUTPUT FILE NAME: ",A64)') NAOUT
        WRITE(LUTRM,'(/,5X,"DO YOU WISH TO WRITE A TITLE LINE ON THE",
     *  " OUTPUT FILE? (Y/N)")')
        READ(LUTRM,'(A1)') ANS
        IF(ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
          WRITE(LUTRM,'(/,5X,"ENTER A TITLE LINE.")')
          READ(LUTRM,'(A80)') ITITLE
          WRITE(LUOUTP,'(A1,A80,A1)') QUOTE,ITITLE,QUOTE
        END IF
      END IF
      IEXIST = .FALSE.
      IF (PLT .NE. 0) THEN
         WRITE(LUTRM,'(/,5X,"ENTER OUTPUT PLOT FILE NAME.")')
   15    READ(LUTRM,'(A64)') NAPLT
         INQUIRE(FILE=NAPLT,EXIST=IEXIST)
        IF(IEXIST) THEN
         WRITE(LUTRM,'(5X,"*** FILE NAME:  ",A64,/,5X,
     *   "ALREADY EXISTS.  DO YOU WISH TO OVERWRITE IT? (Y/N)")')
     *    NAPLT
         READ(LUTRM,'(A1)') ANS
```

```
    IF(ANS .EQ. 'Y' .OR. ANS .EQ. 'y') THEN
      OPEN(LUPLT,FILE=NAPLT,IOSTAT=IERR,STATUS='OLD')
      REWIND(UNIT=LUPLT)
    ELSE
      WRITE(LUTRM,'(/,5X,"ENTER A NEW FILE NAME")')
      GOTO 15
    END IF
  ELSE
    OPEN(LUPLT,FILE=NAPLT,IOSTAT=IERR,STATUS='NEW')
  END IF
  WRITE(LUTRM,'(//,5X,"PLOT FILE NAME: ",A64)') NAPLT
END IF
RETURN
END
```

```
      SUBROUTINE LOCFRC (JE,DISP,ROT,AFORCE,BMOMT,E,INDEX,I1,STRAIN,STRE
     1SS,STRS,SMASS,IX,EL,MTYP,NOPT,NUMEL,ZC,INMESH)
C
Cbrc
Cbrc  ADDED INCLUDES AND REMOVED GO TO'S - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      INCLUDE 'ADJUST.COM'
      INCLUDE 'DYNAM.COM'
      INCLUDE 'CONTRL.COM'
C
      DIMENSION DISP(2), ROT(6), AFORCE(6), BMOMT(6), E(12,NE), INDEX(
     1      NINDEX), STRAIN(NSTRAI), STRESS(NSTRES), SMASS(
     2      NSMASS), IX(14,NIX), STRS(NSTRS)
      DIMENSION ZC(NZC),INMESH(NINMEH)
C
C
      DATA ISKIP/0/
C
C.... NOPT=1 - 3-D AXIAL SPRING ELEMENT
C.... NOPT=2 - 3-D LINEAR, ELASTIC RECTANGULAR BEAM ELEMENT
C.... NOPT=3 - 3-D SPINAL DISK BEAM ELEMENT.
C
C MODIFIED FEB, 1978
C  A. CUBIC STIFFENING OF SPRING ELEMENTS
C    1. EXPLICIT ONLY
C    2. STIFFNESS PROPORTIONAL DAMPING ONLY
C
C  B. CALL TO INJURY CRITERIA SUBROUTINE
C    1. IF KONTRL(15) = 1
C
      IF (NOPT.EQ.1) IND=INDEX(JE)+12
      IF (NOPT.EQ.2) IND=INDEX(JE)+24
      IF (NOPT.EQ.3) IND=INDEX(JE)+34
      INDB=INDEX(JE)+36
      SDPY=E(9,MTYP)
      SDPZ=E(10,MTYP)
      EPSOLD=STRS(IND)
      STRS(IND)=DISP(2)
      IF (I1.GT.1) GO TO 16
C
      IF (NOPT.LE.2) THEN
       STRAIN(1)=DISP(2)
       STRAIN(2)=DISP(2)
C
C.... CALCULATE ELEMENT STRESSES
C.... CALL STRES(JE,MTYP,STRAIN,STRESS,E,STRS,I1,IND)
C
       STRESS(1)=E(2,MTYP)*STRAIN(1)
C
C.... STORE STRESSES AND STRAINS IN STRS
C
       STRS(IND)=STRAIN(1)
       STRS(IND+1)=STRESS(1)
      END IF
C
C.... CALCULATE ELEMENT STIFFNESSES
C
      CSTIF=0.D0

      IF (NOPT.EQ.1) THEN
       ASTIF=E(2,MTYP)*E(7,MTYP)/EL
       IF (E(7,MTYP).LT.0.) ASTIF=E(2,MTYP)
       CSTIF=0.D0
       CSTIF=E(3,MTYP)
      ELSE IF (NOPT.EQ.2) THEN
       ASTIF=E(2,MTYP)*E(7,MTYP)/EL
       IF (E(7,MTYP).LT.0.) ASTIF=E(2,MTYP)
       CSTIF=0.D0
       YM=E(2,MTYP)
       POIS=E(6,MTYP)
       H=E(8,MTYP)
       T=E(5,MTYP)
       SM=YM/(2.D0*(1.D0+POIS))
       BYSTIF=YM*(H*T**3)/(EL*12.D0)
```

```
      BZSTIF=YM*(T*H**3)/(EL*12.D0)
      IF (H.GT.T) THEN
       TSTIF=.237D0*SM*(H*T**3)/EL
      ELSE
       TSTIF=.237D0*SM*(T*H**3)/EL
      END IF
     ELSE IF (NOPT.EQ.3) THEN
      ASTIF=E(1,MTYP)
      TSTIF=E(2,MTYP)
      AYROT=(DABS(ROT(3))+DABS(ROT(4)))/2.D0
      AZROT=(DABS(ROT(5))+DABS(ROT(6)))/2.D0
      BYSTIF=E(3,MTYP)+E(5,MTYP)*AYROT*AYROT
      BZSTIF=E(4,MTYP)+E(6,MTYP)*AZROT*AZROT
     END IF
C
C.... CALCULATE INTERNAL ELEMENT DAMPING FORCES
C
     FDAMP=0.D0
     DMIY=0.D0
     DMJY=0.D0
     DMIZ=0.D0
     DMJZ=0.D0
C
C.... PERCENT CRITICAL DAMPING
C
     IF (KONTRL(8).LE.0) THEN
      PCAD=E(11,MTYP)
      N3=IX(3,JE)
      N4=IX(4,JE)
      N3N=6*(N3-1)+1
      N4N=6*(N4-1)+1

      IF (PCAD.NE.0.) THEN
       AMASS=(SMASS(N3N)+SMASS(N4N))/2.D0
       DDOT=(DISP(2)-EPSOLD)*EL/DELT
       FDAMP=2.D0*PCAD*DDOT*DSQRT(AMASS*ASTIF)
      END IF

      IF (NOPT.NE.1) THEN
       PCBD=E(12,MTYP)
       IF (PCBD.NE.0.) THEN
        AYMASS=(SMASS(N3N+4)+SMASS(N4N+4))/2.D0
        AZMASS=(SMASS(N3N+5)+SMASS(N4N+5))/2.D0
        DYDOT=(ROT(3)-STRS(INDB+1)-ROT(4)+STRS(INDB+2))/DELT
        DZDOT=(ROT(5)-STRS(INDB+3)-ROT(6)+STRS(INDB+4))/DELT
        DMIY=2.D0*PCBD*DYDOT*DSQRT(AYMASS*BYSTIF)
        DMJY=-DMIY
        DMIZ=2.D0*PCBD*DZDOT*DSQRT(AZMASS*BZSTIF)
        DMJZ=-DMIZ
       END IF
      END IF
C
C.... VISCOUS DAMPING
C
     ELSE IF (KONTRL(8).GT.0) THEN
      PVAD=E(11,MTYP)
      IF (NOPT.EQ.1) THEN
       IF (PVAD.NE.0) FDAMP=PVAD*ASTIF*(DISP(2)-EPSOLD)*EL/DELT
      ELSE
       IF (PVAD.NE.0) FDAMP=PVAD*ASTIF*(DISP(2)-EPSOLD)*EL/DELT
       PVBD=E(12,MTYP)
       IF (PVBD.NE.0.) THEN
        DYI=(ROT(3)-STRS(INDB+1))/DELT
        DYJ=(ROT(4)-STRS(INDB+2))/DELT
        DZI=(ROT(5)-STRS(INDB+3))/DELT
        DZJ=(ROT(6)-STRS(INDB+4))/DELT
        DMIY=PVBD*BYSTIF*((4.D0+SDPZ)*DYI+
     1              (2.D0-SDPZ)*DYJ)/(1.D0+SDPZ)
        DMJY=PVBD*BYSTIF*((2.D0-SDPZ)*DYI+
     1              (4.D0+SDPZ)*DYJ)/(1.D0+SDPZ)
        DMIZ=PVBD*BZSTIF*((4.D0+SDPY)*DZI+
     1              (2.D0-SDPY)*DZJ)/(1.D0+SDPY)
        DMJZ=PVBD*BZSTIF*((2.D0-SDPY)*DZI+
     1              (4.D0+SDPY)*DZJ)/(1.D0+SDPY)
       END IF
      END IF
```

```
      END IF
C
C.... CALCULATE ELEMENT INTERNAL FORCES
C
      IF (NOPT.NE.1) THEN
       TORC=0.D0
       DNOL=DISP(2)*EL
C
C.... SPRING ELEMENT  TORC IS TENSION OR COMPRESSION OPTION
C.... TORC < 0  SPRING IS COMPRESSION ONLY
C.... TORC = 0  SPRING IS BOTH TENSION AND COMPRESSION
C.... TORC > 0  SPRING IS TENSION ONLY
C
      ELSE IF (NOPT.EQ.1) THEN
       TORC=E(1,MTYP)
       SLACK=E(4,MTYP)
       DNOL=(DISP(2)-SLACK)*EL

       IF (TORC.LT.0) THEN
        IF (DNOL.GE.0.) DNOL=0.D0
       ELSE IF (TORC.GT.0) THEN
        IF (DNOL.LE.0.) DNOL=0.D0
       END IF
      END IF

      AFORCE(2)=(ASTIF+CSTIF*DNOL*DNOL)*DNOL+FDAMP
      IF (TORC.LT.0..AND.AFORCE(2).GT.0.) AFORCE(2)=0.D0
      IF (TORC.GT.0..AND.AFORCE(2).LT.0.) AFORCE(2)=0.D0
      AFORCE(1)=-AFORCE(2)
      IF (NOPT.EQ.1) GO TO 17
C
C.... CALCULATE INTERNAL MOMENTS
C
      BMOMT(2)=TSTIF*ROT(1)
      BMOMT(1)=-BMOMT(2)
      BMOMT(3)=DMIY+BYSTIF*((4.D0+SDPZ)*ROT(3)+(2.D0-SDPZ)*ROT(4))/
     1      (1.D0+SDPZ)
      BMOMT(4)=DMJY+BYSTIF*((2.D0-SDPZ)*ROT(3)+(4.D0+SDPZ)*ROT(4))/
     1      (1.D0+SDPZ)
      BMOMT(5)=DMIZ+BZSTIF*((4.D0+SDPY)*ROT(5)+(2.D0-SDPY)*ROT(6))/
     1      (1.D0+SDPY)
      BMOMT(6)=DMJZ+BZSTIF*((2.D0-SDPY)*ROT(5)+(4.D0+SDPY)*ROT(6))/
     1      (1.D0+SDPY)
C
      AFORCE(4)=-(BMOMT(5)+BMOMT(6))/EL
      AFORCE(3)=-AFORCE(4)
      AFORCE(6)=(BMOMT(3)+BMOMT(4))/EL
      AFORCE(5)=-AFORCE(6)
C
      IF(KONTRL(15).EQ.0) GO TO 17

      IF(TIME.LT.DELT .AND. ISKIP.LE.0) THEN
       READ(5,100) JSTART,JEND
       WRITE(6,100) JSTART,JEND
       NB=JEND-JSTART
       ISKIP=1
      END IF

      IF(JE.LT.JSTART.OR.JE.GT.JEND) GO TO 17
      CALL SPINIF (JE,JSTART,JEND,NB,AFORCE,BMOMT,ZC,NZC,INMESH,NINMEH)
      GO TO 17
C
C.... ELASTO - PLASTIC BEAMS
C
   16 IND=INDEX(JE)+41
      IGO=0
      ISEC=IX(11,JE)
C
C.... CALCULATE AND STORE INTERNAL ENERGIES
C
   17 IKE=INDEX(NUMEL+1)
      IF (NOPT.NE.1) IND=INDEX(JE)+24
      IADD=11
      IF (NOPT.EQ.1) IADD=3
C
      IABE=2
```

```
      IF(NOPT.EQ.3) IABE=0
      DLN=DISP(2)*EL
      STRS(IKE+MTYP)=STRS(IKE+MTYP)+.5D0*(AFORCE(2)+STRS(IND+IABE))
     * *(DLN-STRS(IND+IADD))
      STRS(IND+IADD)=DLN

      IF (NOPT.NE.1) THEN
       IADD=1
       IF (NOPT.EQ.2) IADD=3
       ROT(2)=ROT(1)
       DO KK=2,6
        KI=IND+10+KK
        DRN=ROT(KK)-STRS(KI)
        STRS(IKE+MTYP)=STRS(IKE+MTYP)+.5D0*(BMOMT(KK)+STRS(
     1            IND+IADD+KK))*DRN
        STRS(KI)=ROT(KK)
       END DO
      END IF
C
C.... STORE LOCAL INTERNAL FORCES
C
      IF (NOPT.EQ.1) THEN
       STRS(IND+2)=AFORCE(2)
       RETURN
      ELSE IF (NOPT.EQ.2) THEN
       N=IND+2
      ELSE IF (NOPT.EQ.3) THEN
       N=IND
      END IF

      STRS(N)=AFORCE(2)
      STRS(N+1)=AFORCE(4)
      STRS(N+2)=AFORCE(6)
      DO I=2,6
       STRS(N+1+I)=BMOMT(I)
      END DO

      RETURN

  100 FORMAT (2I10)

      END
```

```
FUNCTION LOFIX (I)
LOFIX=I
RETURN
END
```

```
      SUBROUTINE PLOTER ( NUMPNT, XARRAY, YARRAY, CLABEL, ULABEL, M, N )
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C....       A PLOTTING SUBROUTINE FOR THE LINE PRINTER]]
C....       DUE TO THE COLUMN AND ROW WIDTHS, THIS SUBROUTINE MUS
C....     DO QUITE A BIT OF TRUNCATING,  HENCE THE ACCURACY OF THE P
C....     IS RELATIVELY CRUDE.   HOWEVER, THE MAIN ADVANTAGE OF USIN
C....     THIS SUBROUTINE IS THE SPEED OF THE LINE PRINTER OUTPUT.
C....     ALSO NO SPECIAL HANDLING INSTRUCTIONS ARE REQUIRED.
C....     ...........................................................
C....     .
C....     .  NUMPNT    IS THE NUMBER DATA POINTS TO BE PLOTTED
C....     .            (NUMPNT MUST NOT EXCEED 500, BUT IF IT
C....     .            ONLY THE FIRST 500 POINTS ARE CONSIDER
C....     .
C....     .  XARRAY    IS THE NAME OF THE ARRAY CONTAINING THE X-C
C....     .
C....     .  YARRAY    IS THE NAME OF THE ARRAY CONTAINING THE Y-C
C....     .
C....     .  CLABEL    IS THE GRAPH LABEL
C....     .
C....     .  ULABEL    IS THE UNITS LABEL
C....     .
C....     .  XMIN      IS THE MINIMUM X-VALUE FOR THE PLOTTING RAN
C....     .
C....     .  XMAX      IS THE MAXIMUM X-VALUE FOR THE PLOTTING RAN
C....     .
C....     .  YMIN      IS THE MINIMUM Y-VALUE FOR THE PLOTTING RAN
C....     .
C....     .  YMAX      IS THE MAXIMUM Y-VALUE FOR THE PLOTTING RAN
C....     .
C....     ...........................................................
C....     NOTE... A) THE SUBROUTINE PAGE EJECTS TO A NEW PAGE TO B
C....             PLOTS, HOWEVER IT DOES NOT PAGE EJECT WHEN FI
C....             AND TWO LINES REMAIN AT THE BOTTOM OF THE PAG
C....             (THESE REMAINING LINES MAY BE USED TO IDENTIF
C....             GRAPHS, IF WISHED, IN THE CALLING PROGRAM.)
C....           B) THE PROGRAM AUTOMATICALLY PLOTS OVER A WHOLE
C....           C) THE X AND Y ARRAYS REMAIN INTACT IN THE SUBRO
C....             AND ARE RETURNED EXACTLY AS SENT.
C....           D) IF MORE THAN ONE POINT EXISTS AT A LOCATION,
C....             AN M-CHARACTER IS PLACED AT THAT POINT.
C....           E) IF SOME POINTS ARE OUT OF THE RANGE OF THE GR
C....             THEY ARE PLOTTED ON THE BORDERS.   (HENCE THE
C....             POINTS ARE INVALID.)
C....  BEGINNING OF ACTUAL  SUBROUTINE PLOTER...
C
      INCLUDE 'ADJUST.COM'
      DIMENSION CHAR(101), XARRAY(NT), YARRAY(NA), IX(501), IY(501),
     *     YVAL(3), CLABEL(10), ULABEL(10)
      DATA BLANK,STAR,YPNT,XPNT,DOT,PNTM/1H ,1H*,1HY,1HX,1H.,1HM/
C
C....            ... IF NUMPNT>500, REDEFINE AS 500 ...
C
      IF (NUMPNT.GT.500) NUMPNT=500

      DO JDUM=1,501
       IX(JDUM)=1
       IY(JDUM)=1
      END DO
C
      XMIN=XARRAY(1)
      XMAX=XARRAY(1)
      YMIN=YARRAY(1)
      YMAX=YARRAY(1)

      DO IZ=1,NUMPNT
       IF (XARRAY(IZ).GT.XMAX) XMAX=XARRAY(IZ)
       IF (XARRAY(IZ).LT.XMIN) XMIN=XARRAY(IZ)
       IF (YARRAY(IZ).GT.YMAX) YMAX=YARRAY(IZ)
       IF (YARRAY(IZ).LT.YMIN) YMIN=YARRAY(IZ)
      END DO

      NUMBER=51
      FLNUMB=NUMBER
```

```
C
    YVAL(1)=YMAX
    YVAL(2)=(YMAX+YMIN)/2.D0
    YVAL(3)=YMIN
C
C.... ..............    SETTING UP X AND Y INTEGER ARRAYS   ............
C
    DO JJ=1,NUMPNT
C
     IF (YMAX-YMIN.EQ.0.) GO TO 7
     IY(JJ)=((YARRAY(JJ)-YMIN)/(YMAX-YMIN))*(FLNUMB-1.D0)+.5D0
     IF (IY(JJ) .GT. NUMBER) IY(JJ)=NUMBER
     IF (IY(JJ)) 6,6,8
  6  IY(JJ)=1
C
     IF (XMAX-XMIN.GT.0.) GO TO 8
  7  WRITE (6,901)
     GO TO 50
  8  IX(JJ)=((XARRAY(JJ)-XMIN)/(XMAX-XMIN))*(100.D0)+.5D0
     IF (IX(JJ) .GT. 101) IX(JJ)=101
     IF (IX(JJ) .LE. 0) IX(JJ)=1
C
    END DO
C
C.... .................. SORTING INTO DESCENDING IY-ARRAY ORDER   .......
C
    LIM=NUMPNT-1
  13 INT=1
    DO I=1,LIM
     IF (IY(I+1) .LE. IY(I)) CYCLE
     TEMP=IX(I+1)
     IX(I+1)=IX(I)
     IX(I)=TEMP
     TEMP2=IY(I+1)
     IY(I+1)=IY(I)
     IY(I)=TEMP2
     INT=I
    END DO
    IF (INT-1) 16,17,16
  16 LIM=INT-1
    GO TO 13
  17 CONTINUE
C
C....            END OF SORTING LOOP
C.... *****************************************************************
C....            FINDING X-AXIS & Y-AXIS POSITIONS, IF PRESENT]
C
    IXKODE=0
    IYKODE=0
C
C....              ...FIRST THE Y-AXIS...
C
    IF (YMAX*YMIN) 18,18,21
  18 IXAXIS=(YMAX/(YMAX-YMIN))*FLNUMB+.5D0
    IF (IXAXIS .LE. 0) IXAXIS=1
    IXKODE=1
C
C....              ...THEN THE X-AXIS...
C
  21 IF (XMAX*XMIN) 22,22,25
  22 IYAXIS=((-XMIN)/(XMAX-XMIN))*101.D0+.5D0
    IF (IYAXIS .LE. 0) IYAXIS=1
    IYKODE=1
  25 CONTINUE
C
    IF (M .EQ. -1) THEN
     WRITE(6,908) (CLABEL(J), J=1,10)
    ELSE IF (M .GT. N) THEN
     WRITE(6,902) (CLABEL(I), I=1,10), (ULABEL(J), J=1,7)
    ELSE
     WRITE (6,907)  (CLABEL(I), I=1,10), (ULABEL(J), J=1,10)
    END IF
C
C.... *****************************************************************
C....            BEGINNING OF ACTUAL PLOT LOOP
C
```

```
      KNTR=1
      KNTYAX=0
C
      DO 49 LL=1,NUMBER
C
C....           SET UP PLOT LINE
C....             PLUG IN X-AXIS IF PRESENT  (IXKODE = 1)
C
       IF (IXKODE) 29,29,26
 26    IF (LL-IXAXIS) 29,27,29
 27    DO IJK=1,101
        CHAR(IJK)=XPNT
       END DO
       GO TO 37
C
 29    CHAR(1)=DOT
       CHAR(101)=DOT
C
       DO K=2,100
        IF (LL-1) 30,33,30
 30      IF (LL-NUMBER) 31,33,31
C
C....              BLANK OUT ROW
C
 31      CHAR(K)=BLANK
       END DO

       GO TO 35
C
C....             IF FIRST OR LAST LINE, ADD BORDER DOTS
C
 33    DO KK=2,100
        CHAR(KK)=DOT
       END DO
C
C....             IF IYKODE KNTR SET, ADD Y AXIS LABEL
C
 35    IF (IYKODE .GT. 0) CHAR(IYAXIS)=YPNT
 37    CONTINUE
C
       IF (IY(KNTR)-((NUMBER+1)-LL)) 44,38,44
C
 38    ICOL=IX(KNTR)
       IF (CHAR(ICOL)-STAR) 39,40,39
 39    IF (CHAR(ICOL)-PNTM) 41,40,41
 40    CHAR(ICOL)=PNTM
       GO TO 42
C
 41    CHAR(ICOL)=STAR
C
 42    IF (KNTR-NUMPNT) 43,44,43
 43    KNTR=KNTR+1
       IF (IY(KNTR-1)-IY(KNTR)) 44,38,44
C
C....             PRINTOUT COMPLETED ROW
C
 44    IF (LL-1) 48,48,45
 45    IF (LL-26) 46,48,46
 46    IF (LL-NUMBER) 47,48,47
C
 47    WRITE (6,903) CHAR
       GO TO 49
C
 48    KNTYAX=KNTYAX+1
       WRITE (6,904) YVAL(KNTYAX),DOT,DOT,CHAR
C
 49    CONTINUE
C
C....            END OF PLOTTING LOOP
C.... *********************************************************************
C
      XMID=(XMIN+XMAX)/2.D0
      WRITE (6,905) XMIN,XMID,XMAX
C
      IF ( M .EQ. -1 )  GO TO 54
C
```

```
 50 WRITE (6,906)
    RETURN
C
C
 54 WRITE (6,909)  (ULABEL(J), J=1,10)
    RETURN

901 FORMAT (1H1//51X,19HALL VALUES ARE ZERO///)
902 FORMAT ( '1', 30X, 10A4, 10X, 8A4, // )
903 FORMAT (20X,101A1)
904 FORMAT(4X,D11.4,3X,2A1,101A1)
905 FORMAT(2(20X,1H.,49X,1H.,49X,1H./),15X,D11.4,39X,D11.4,40X,D11.4
   1 ,/)
906 FORMAT (59X,14HTIME - SECONDS)
907 FORMAT ( '1', 30X, 10A4, 10X, 10A4, // )
908 FORMAT ( '1', 50X, 10A4, // )
909 FORMAT ( 50X, 10A4 )
    END
```

```
      SUBROUTINE READIN (SMASS,E,XC,YC,ZC,NODE,XT,YT,ZT,MESHIN,INMESH,NO
     1DDIS,ANGLE)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      INCLUDE 'SIZE.COM'
      INTEGER PRITYP,SECTYP
      DIMENSION XC(NXC), YC(NYC), ZC(NZC), E(12,NE), NODE(14,NIX),
     1      NODDIS(NNODIS), XT(NXO), YT(NX1), ZT(NDICOS), JJ(7),
     2      SMASS(NSMASS), ANGLE(9,NANGLE), NNREAD(8), MESHIN(
     3      NMESHN), INMESH(NINMEH), TMASS(4)
      INCLUDE 'DYNAM.COM'
      INCLUDE 'OUTPA.COM'
      INCLUDE 'CONTRL.COM'
C$
C$ COMMON STATEMENTS ADDED TO ACCOMODATE I/O DECLARATIONS
C$
      COMMON /DEVS/LUTRM, LUIN, LUOUT, LUPLT
      COMMON /LABELS/NAINP,NAOUT,NAPLT
      DATA PRITYP,SECTYP/1HP,1HS/
      WRITE (6,901) NNODE,NPRI,NAXOR,NELE,NUMMAT,NUMDIS,MXSTEP,NDGREE,DE
     1LT,NODMAX
      NODET=NNODE+NAXOR
      READ (5,902) (KONTRL(I),I=1,16)
      WRITE (6,903) KONTRL(1)
      WRITE (6,904) KONTRL(2)
      WRITE (6,905) KONTRL(3)
      WRITE (6,906) KONTRL(4)
      WRITE (6,907) KONTRL(5)
      WRITE (6,908) KONTRL(6)
      WRITE(6,913) KONTRL(7)
      WRITE(6,915) KONTRL(8)
      WRITE(6,916) KONTRL(9)
      WRITE(6,917) KONTRL(10)
      WRITE(6,918) KONTRL(11)
      WRITE(6,9180) KONTRL(12)
      WRITE(6,9181) KONTRL(13)
      WRITE(6,9182) KONTRL(14)
      WRITE(6,9183) KONTRL(15)
      WRITE(6,9184) KONTRL(16)
      DO I=1,NUMMAT
       READ (5,919) MTYPE
       READ (5,920) (E(J,MTYPE),J=1,12)
       WRITE (6,921) MTYPE,(E(J,MTYPE),J=1,12)
      END DO
C
C....  READ AND PRINT NODAL POINT DATA
C
      NEQ=NPRI*NDGREE
      DO LEN=1,NEQ
       SMASS(LEN)=0.D0
      END DO

      IF (KONTRL(1) .EQ. 1) THEN
       WRITE(6,923)
      ELSE
       WRITE(6,922)
      END IF

      WRITE (6,924)
      INTPRI=0
      NCOUNT=0
      INTSEC=NPRI
    5 READ (5,926) MESH,NODTYP,XORD,YORD,ZORD,(TMASS(K),K=1,4)
      NCOUNT=NCOUNT+1
      IF (NNODE.EQ.NPRI) GO TO 8
      IF (TMASS(1)) 6,7,8
    6 WRITE (6,927) MESH,TMASS(1)
      STOP
    7 IF (NODTYP.EQ.PRITYP) GO TO 8
      IF (NODTYP.EQ.SECTYP) GO TO 9
      IF(KONTRL(7)) 9,9,8
    8 INTPRI=INTPRI+1
      INT=INTPRI
      GO TO 10
```

```
 9 INTSEC=INTSEC+1
   INT=INTSEC
 10 WRITE (6,925) INT,MESH,NODTYP,XORD,YORD,ZORD,(TMASS(K),K=1,4)
   INMESH(MESH)=INT
   MESHIN(INT)=MESH
   XC(INT)=XORD
   YC(INT)=YORD
   ZC(INT)=ZORD
C
   IF (TMASS(1).NE.0.) THEN
    LEN=NDGREE*(INT-1)+1
    SMASS(LEN)=TMASS(1)
    SMASS(LEN+1)=TMASS(1)
    SMASS(LEN+2)=TMASS(1)
    SMASS(LEN+3)=TMASS(2)
    SMASS(LEN+4)=TMASS(3)
    SMASS(LEN+5)=TMASS(4)
   END IF

   IF (NNODE-NCOUNT) 12,13,5
 12 WRITE (6,928) MESH
   STOP
 13 CONTINUE
   IF (NAXOR.LE.0) GO TO 15
 14 READ (5,926) MESH,NODTYP,XORD,YORD,ZORD
   NCOUNT=NCOUNT+1
   INTSEC=INTSEC+1
   WRITE (6,925) INTSEC,MESH,NODTYP,XORD,YORD,ZORD
   INMESH(MESH)=INTSEC
   MESHIN(INTSEC)=MESH
   XC(INTSEC)=XORD
   YC(INTSEC)=YORD
   ZC(INTSEC)=ZORD
   IF (NODET-NCOUNT) 12,15,14
C
 15 CONTINUE
C
C....  READ AND PRINT ELEMENT NODES
C
   WRITE (6,929)
   N=0
 16 N=N+1
   READ (5,930) M,(NNREAD(LEN),LEN=1,8),(NODE(K,N),K=9,14)
   DO LEN=1,8
    NLEN=NNREAD(LEN)
    IF (NLEN .EQ. 0) THEN
     NODE(LEN,N)=0
    ELSE
     NODE(LEN,N)=INMESH(NLEN)
    END IF
   END DO

   WRITE (6,931) N,(NNREAD(I),I=1,8),(NODE(K,N),K=9,14),(NODE(J,N),J=
  11,4),NODE(8,N)
   IF (N.LT.NELE) GO TO 16
C
C.... PRINT NODAL DATA IN COORDINATE SYSTEM NOT INPUT
C.... PASS ON TO REMAING CODE NODAL DATA IN GLOBAL COORDINATES
C.... REGARDLESS OF WHICH SYSTEM WAS CHOOSEN FOR INPUT
C
   IF (KONTRL(1).EQ.1) GO TO 30
   WRITE (6,932)
   WRITE (6,924)
C
   SIGN=1.D0
C
 19 DO 29 KK=1,NELE
C
C....  CHECK FOR PVP ELEMENTS  (ETYPE=4)
C
    IF (NODE(10,KK).EQ.4) GO TO 22
C
    N1=NODE(1,KK)
    N2=NODE(2,KK)
    N3=NODE(3,KK)
    N4=NODE(4,KK)
```

```
C
C....   CHECK FOR PLATE ELEMENTS  (ETYPE=5)
C
      IF (NODE(10,KK).EQ.5) GO TO 24
C
C....  CHECK FOR PRIMARY OR SECONDARY NODES
C
      IF (N3 .EQ. 0) THEN
       N3=N1
       NODE(3,KK)=N1
      END IF

      IF (N4 .EQ. 0) THEN
       N4=N2
       NODE(4,KK)=N2
      END IF

      XT(N1)=XC(N1)-XC(N3)*SIGN
      YT(N1)=YC(N1)-YC(N3)*SIGN
      ZT(N1)=ZC(N1)-ZC(N3)*SIGN
      XT(N2)=XC(N2)-XC(N4)*SIGN
      YT(N2)=YC(N2)-YC(N4)*SIGN
      ZT(N2)=ZC(N2)-ZC(N4)*SIGN
      XT(N3)=XC(N3)
      YT(N3)=YC(N3)
      ZT(N3)=ZC(N3)
      XT(N4)=XC(N4)
      YT(N4)=YC(N4)
      ZT(N4)=ZC(N4)
C
      GO TO 29
C
   22 N7=NODE(7,KK)
      N8=NODE(8,KK)
      DO II=1,3
       NI=NODE(II,KK)
       NJ=NODE(II+3,KK)
       XT(NI)=XC(NI)-XC(N7)*SIGN
       YT(NI)=YC(NI)-YC(N7)*SIGN
       ZT(NI)=ZC(NI)-ZC(N7)*SIGN
       XT(NJ)=XC(NJ)-XC(N8)*SIGN
       YT(NJ)=YC(NJ)-YC(N8)*SIGN
       ZT(NJ)=ZC(NJ)-ZC(N8)*SIGN
      END DO
      XT(N7)=XC(N7)
      YT(N7)=YC(N7)
      ZT(N7)=ZC(N7)
      XT(N8)=XC(N8)
      YT(N8)=YC(N8)
      ZT(N8)=ZC(N8)
C
      GO TO 29
C
   24 N5=NODE(5,KK)
      N6=NODE(6,KK)
      IF (N4.NE.0) GO TO 25
      N4=N1
      NODE(4,KK)=N1
   25 IF (N5.NE.0) GO TO 26
      N5=N2
      NODE(5,KK)=N2
   26 IF (N6.NE.0) GO TO 27
      N6=N3
      NODE(6,KK)=N6
   27 DO II=1,3
       NI=NODE(II,KK)
       NJ=NODE(II+3,KK)
       XT(NI)=XC(NI)-XC(NJ)*SIGN
       YT(NI)=YC(NI)-YC(NJ)*SIGN
       ZT(NI)=ZC(NI)-ZC(NJ)*SIGN
       XT(NJ)=XC(NJ)
       YT(NJ)=YC(NJ)
       ZT(NJ)=ZC(NJ)
      END DO
C
   29 CONTINUE
```

```
      WRITE (6,933) (KK,MESHIN(KK),XT(KK),YT(KK),ZT(KK),KK=1,NNODE)
C
      IF (SIGN) 31,33,33
C
   30 WRITE (6,934)
      WRITE (6,924)
C
      SIGN=-1.0
C
      GO TO 19
   31 DO KK=1,NNODE
        XC(KK)=XT(KK)
        YC(KK)=YT(KK)
        ZC(KK)=ZT(KK)
      END DO
   33 CONTINUE
C
C....  READ DISPLACEMENT NODE CODES
C
      NPDIS=0
      IF (NUMDIS.EQ.0) GO TO 38
      WRITE (6,935)
      DO I=1,NUMDIS
        READ (5,936) (JJ(K),K=1,7),(ANGLE(LS,I),LS=1,6)
        JJ1=JJ(1)
        JJ(1)=INMESH(JJ1)
        DO J=2,7
          IF (JJ(J).GT.1) NPDIS=NPDIS+1
        END DO
        CALL INCODE (NODDIS(I),JJ,3,7)
        CALL DECOD (NODDIS(I),JJ,3,7)
        IF (JJ(7).GT.NNODE) WRITE (6,947) JJ(7)
        JJ1=JJ(7)
        JJ(7)=MESHIN(JJ1)
        DO LS=1,3
          IF (ANGLE(LS,I).NE.0.) GO TO 36
        END DO
        ANGLE(1,I)=1.D0
        ANGLE(5,I)=1.D0
   36   CALL CROSS (ANGLE(1,I),ANGLE(4,I),ANGLE(7,I),DUM,CMAG,0)
        WRITE (6,937) I,JJ(7),(JJ(J),J=1,6),(ANGLE(LS,I),LS=1,6)
      END DO
   38 CONTINUE
C
      RETURN

  901 FORMAT (1H0,4X,37HNUMBER OF PRIMARY AND SECONDARY NODES,I10/5X,37H
     1NUMBER OF PRIMARY NODES            ,I10/5X,37HNUMBER OF AXIS ORI
     2ENTATION NODES     ,I10/5X,37HNUMBER OF ELEMENTS
     3 ,I10/5X,37HNUMBER OF MATERIALS                ,I10/5X,37HNUMBER
     4 OF FIXED NODES           ,I10/5X,37HMAXIMUM NUMBER OF INCREM
     5ENTS         ,I10/5X,37HNO. OF DEGREES OF FREEDOM PER NODE   ,I10/
     65X,37HTIME INCREMENT                    ,1PD16.5,/5X,37HMAXIMUM
     7 NODE NUMBER              ,I10,/)
  902 FORMAT (16I5)
  903 FORMAT (/1X,10HKONTRL(1)=,I5,10X,47H0 - SECONDARY NODES INPUT IN G
     1LOBAL COORDINATES,/,26X,46H1 - SECONDARY NODES INPUT IN LOCAL COOR
     2DINATES)
  904 FORMAT (/,7X,4H(2)=,I5,10X,34H1 - OMIT PRINTING OF UOUT AND SOUT)
  905 FORMAT (/,7X,4H(3)=,I5,10X,44H0 - USE EIGEN TO FIND PRINCIPLE INER
     1TIA AXES,/,26X,54H1 - PRINCIPLE INERTIA AXES ARE THE SAME AS GLOBA
     2L AXES,/,26X,54H2 - INITIAL ORIENTATION DATA FOR RIGID BODIES IS I
     3NPUT)
  906 FORMAT (/,7X,4H(4)=,I5,14X,34HNUMBER OF SLIDING INTERFACE PLANES)
  907 FORMAT(/,7X,4H(5)=,I5,10X,45HNEWMARK - BETA TEMPORAL INTEGRATION P
     1ARAMETER,/,26X,48H0 - EXPLICIT ( ONLY OPTION CURRENTLY AVAILABLE )
     2)
  908 FORMAT(/,7X,4H(6)=,I5,10X,'NO. OF SECONDARY BODIES FOR CONTACT')
  913 FORMAT(/,7X,4H(7)=,I5,10X,'0 - DEFAULT NODE TYPE S SECONDARY NODE'
     ,/,26X,'1 - DEFAULT NODE TYPE P PRIMARY NODE')
  915 FORMAT(/,7X,4H(8)=,I5,10X,37H0 - FRACTION CRITICAL ELEMENT DAMPING
     1      ,/,26X,41H1 - STIFFNESS PROPORTIONAL GLOBAL DAMPING )
  916 FORMAT(/,7X,4H(9)=,I5,10X,'0-RECTANGULAR BEAM CROSS SECTION',  23
     1H(ONE INTEGRATION POINT),/26X,17H1-CROSS SECTIONAL,24HGEOMETRIES T
     2O BE READ IN)
  917 FORMAT(/,6X,5H(10)=,I5,10X,'RESTART CONTROL')
```

```
 918 FORMAT(1H0,5X,5H(11)=,I5,10X,32HQ ARRAY OUTPUT AT THIS TIME STEP)
9180 FORMAT(/,6X,5H(12)=,I5,10X,12H  - NOT USED)
9181 FORMAT(/,6X,5H(13)=,I5,10X,13H0 - NO ACTION,/,26X,52H1 - NUMERICAL
   1 INTEGRATION DATA TO BE READ IN BY ICIF)
9182 FORMAT(/,6X,5H(14)=,I5,10X,'0 - ALL NODES ASSUMED INITIALLY IN CON
   1TACT WITH SEATBACK',/,26X,'1 - ARRAY OF INITIAL DISTANCES FROM SEA
   2TBACK IS INPUT')
9183 FORMAT(/,6X,5H(15)=,I5,10X,13H0 - NO ACTION,/,26X,24H1 - SPINIF DA
   1TA REQUIRED)
9184 FORMAT(/,6X,5H(16)=,I5,10X,13H0 - NO ACTION,/,26X,31H1 - RETRACTIO
   1N / --- SIMULATION)
 919 FORMAT (I5,D10.4)
 920 FORMAT (6D10.4)
 921 FORMAT (1H0,4X,3HMAT,I3,10X/3X,8HE-MATRIX,1P6D18.5/11X,1P6D18.5)
 922 FORMAT (///,1X,41HNODAL DATA AS INPUT IN GLOBAL COORDINATES)
 923 FORMAT (///1X,40HNODAL DATA AS INPUT IN LOCAL COORDINATES)
 924 FORMAT (30H0    INTERNAL NO.    MESH NO.,39H  X-ORDINATE   Y-ORD
   1INATE   Z-ORDINATE)
 925 FORMAT (12X,I4,8X,I4,4X,A1,3F13.3,1P4D15.5)
 926 FORMAT (I5,4X,A1,7D10.4)
 928 FORMAT (1H0,20HNODAL POINT ERROR N=,I5)
 930 FORMAT (15I5)
 931 FORMAT (1X,I8,5X,19I5)
 932 FORMAT (///,1X,31HNODAL DATA IN LOCAL COORDINATES)
 933 FORMAT (12X,I4,8X,I4,3F13.3)
 934 FORMAT (///,1X,32HNODAL DATA IN GLOBAL COORDINATES)
 935 FORMAT (1H0,10X,18HDISPLACEMENT NODES/13X,8HMESH NO.,5X,9HCONDITIO
   1N)
 936 FORMAT (I4,6I1,6D10.4)
 937 FORMAT (5X,I5,5X,I4,5X,6I2,3X,6F10.5)
 947 FORMAT(1H0,5X,25HWARNING DISP. NODE NUMBER   ,I5)
 927 FORMAT(///,1H ,24HNODAL MASS ERROR, NODE=  ,I5,10X,5HMASS=,D20.4)
 929 FORMAT(1H0,/,2X,
   165HELEMENT NO.    N1  N2  N3  N4  N5  N6  N7  COOR MTYP ET
   2YP  ,5X,26H  N1  N2  N3  N4  COOR     )

     END
```

```
      SUBROUTINE READOU(UOUT,SOUT,NPOUT,GLABEL,INMESH,NODE,DP,NSEC,IMPB)

      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      INCLUDE 'ADJUST.COM'
      INCLUDE 'OUTPA.COM'
      INCLUDE 'SIZE.COM'
C$
C$  COMMON STATEMENTS ADDED TO ACCOMODATE I/O DECLARATIONS
C$
      COMMON /DEVS/LUTRM, LUIN, LUOUTP, LUPLT
      COMMON /LABELS/NAINP,NAOUT,NAPLT
      INTEGER UOUT,SOUT,LUTRM, LUIN, LUOUTP, LUPLT

      DIMENSION DP(NDEF)
      DIMENSION INMESH(NINMEH), JJ(7), SOUT(NSOUT), NPOUT(2,NNPOUT),
     1      NODE(14,NIX), UOUT(NUOUT)
      DIMENSION IMPB(NISEC)
      DIMENSION GLABEL( 20,NGLABE )

      WRITE (6,939)
      WRITE (6,940)  NPFREQ, NPRU, NPRS, NPIC, NANG, NPSEC
      IF (NPRU.EQ.0) GO TO 43
      READ (5,941) (UOUT(JQ), (GLABEL(IQ,JQ), IQ=1,17), JQ=1,NPRU)
      WRITE(6,942) (UOUT(JQ), (GLABEL(IQ,JQ), IQ=1,17), JQ=1,NPRU)
      IFLAG=0

      DO I=1,NPRU
       CALL DECOD (UOUT(I),JJ,10,4)
       IF(JJ(3).EQ.3) IFLAG=1
       JJ(4)=INMESH(JJ(4))
       IF ( JJ(4) .GT. NNODE )  GO TO 55
       DO II=1,4
        JJ(6-II)=JJ(5-II)
       END DO
       JJ(1)=JJ(5)
       CALL INCODE (UOUT(I),JJ,10,4)
      END DO

   43 IF (NPRS.EQ.0) GO TO 45
      READ (5,941) (SOUT(JQ), (GLABEL(IQ,NPRU+JQ), IQ=1,17), JQ=1,NPRS)
      WRITE(6,943) (SOUT(JQ), (GLABEL(IQ,NPRU+JQ), IQ=1,17), JQ=1,NPRS)
      DO I=1,NPRS
       CALL DECOD (SOUT(I),JJ,10,4)
       IF ( JJ(4) .GT. NELE )  GO TO 56
      END DO
   45 CONTINUE
      IF (NPIC.LE.0) GO TO 47
      WRITE (6,944)
      DO K=1,NPIC
       READ (5,945) (NPOUT(I,K),I=1,2)
       IF(NPOUT(2,K).EQ.5) IFLAG=1
       WRITE (6,946) (NPOUT(I,K),I=1,2)
      END DO
   47 IF (NPFREQ.LE.0) NPFREQ=1

      NUMHAL=NNODE/2
      K=0
      DO JE=1,NELE
       KJE=NODE(3,JE)-NODE(4,JE)
       IF (NODE(10,JE).EQ.4) KJE=NODE(7,JE)-NODE(8,JE)
       IF (KJE.LT.0) KJE=-KJE
       IF (KJE.GT.K) K=KJE
      END DO
      IF(NANG.EQ.0) GO TO 52
      READ(5,960) AM,(DP(I),DP(I+NANG),DP(I+2*NANG),DP(I+3*NANG),I=1,
     1      NANG)
      WRITE(6,961) AM,(DP(I),DP(I+NANG),DP(I+2*NANG),DP(I+3*NANG),I=1,
     1      NANG)
      NANG=AM*NANG
   52 CONTINUE
      MUD=(K+1)*NDGREE-1
C
      IF(NSEC.LE.0) RETURN
      DO 50 I=1,NSEC
      NA=6*(I-1)
```

```
 50 READ(5,950) II,(IMPB(NA+K),K=1,6)
  RETURN
 55 WRITE (6,948) JJ(4)
  GO TO 60
 56 WRITE (6,949) JJ(4)
 60 CONTINUE

  STOP
939 FORMAT (1H0//5X,11HOUTPUT CODE)
940 FORMAT (1H0,9X,7HNPFREQ=,I10/10X,7HNPRU =,I10/10X,7HNPRS =,
 1     I10/10X,7HNPIC =,I10,/,10X,7HNANG =,I10,/,10X,
 2     7HNPSEC =,I10)
941 FORMAT (I10, 17A4)
942 FORMAT ('0',5X,'UOUT - SELECTIVE NODAL DISPLACEMENT, VELOCITY, ',
 *     'AND ACCELERATION OUTPUT'/,(6X,I10,10X,17A4))
943 FORMAT ('0',5X,'SOUT - SELECTIVE ELEMENT STRESS ARRAY OUTPUT'/
 *     (6X,I10,10X,17A4))
944 FORMAT ('0',5X,'NPOUT PICTURE OUTPUT'/10X,'AT STEP',10X,'CODE')
945 FORMAT (2I10)
946 FORMAT (//10X,I7,10X,I4)
948 FORMAT ('0',5X,'WARNING UOUT NODE NUMBER =',I5)
949 FORMAT ('0',5X,'WARNING SOUT ELEMENT NUMBER =',I5)
950 FORMAT(7I5)
960 FORMAT(8F10.0)
961 FORMAT(1H0,5X,'DEFORMATION AMPLIFICATION FACTOR =',F10.2,//,5X,
 1     'WIDTH',5X,'X-ROTATION',5X,'Y-ROTATION',5X,'Z-ROTATION',
 2     /,(4X,D12.5,3(3X,D12.5)))

  END
```

```
      SUBROUTINE ROTATE (R,V,KODE)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... THIS ROUTINE APPLIES THE ROTATION MATRIX  R  TO THE VECTOR
C....   V  AS INDICATED BY THE PARAMETER  KODE
C....   KODE = 1  V = R * V
C....   KODE = 2  V = R(TRAN) * V
C.... IF KODE IS NEGATIVE  V  IS A SIX ELEMENT VECTOR
C
      COMMON /MATRIX/ NAM,NB,NR
      DIMENSION R(6),V(6),T(6)
C
      IKODE=IABS(KODE)
      NAM = 3*3
      NB = 3*1
      NR = 3*1
      GO TO (1,2), IKODE
C
    1 CALL GMPRD (R,V,T,3,3,1)
      IF (KODE.GT.0) GO TO 3
      CALL GMPRD (R,V(4),T(4),3,3,1)
      GO TO 3
C
    2 CALL GTPRD (R,V,T,3,3,1)
      IF (KODE.GT.0) GO TO 3
      CALL GTPRD (R,V(4),T(4),3,3,1)
C
    3 DO 4 I=1,3
        V(I)=T(I)
    4   CONTINUE
      IF (KODE.GT.0) GO TO 6
      DO 5 I=4,6
        V(I)=T(I)
    5   CONTINUE
C
    6 RETURN
      END
```

```
      SUBROUTINE ROTE (THETA,PHI,PSI,XO,YO,ZO,XP,YP,CMAX,NNODE)

      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... THETA= ROTATION ABOUT THE Y AXIS
C.... PHI= ROTATION ABOUT THE X AXIS
C.... PSI=ROTATION ABOUT Z AXIS
Cbrc  VARIABLE NAMES CHANGED BY DJP
C
      INCLUDE 'ADJUST.COM'
      DIMENSION XO(NNODE), YO(NNODE), ZO(NNODE), CA(2), CB(2), CG(2),
     1         XP(NNODE), YP(NNODE), CMAX(6)
      THR=THETA*DATAN(1.D0)/45.D0
      PHIR=PHI*DATAN(1.D0)/45.D0
      PSIR=PSI*DATAN(1.D0)/45.D0
      CA(1)=DCOS(THR)*DCOS(PSIR)-DSIN(THR)*DSIN(PHIR)*DSIN(PSIR)
      CA(2)=-DSIN(THR)*DSIN(PHIR)*DCOS(PSIR)-DCOS(THR)*DSIN(PSIR)
      CB(1)=DCOS(PHIR)*DSIN(PSIR)
      CB(2)=DCOS(PHIR)*DCOS(PSIR)
      CG(1)=-DSIN(THR)*DCOS(PSIR)-DCOS(THR)*DSIN(PHIR)*DSIN(PSIR)
      CG(2)=-DCOS(THR)*DSIN(PHIR)*DCOS(PSIR)+DSIN(THR)*DSIN(PSIR)
      CMAX(1)=XO(1)
      CMAX(2)=XO(1)
      CMAX(3)=YO(1)
      CMAX(4)=YO(1)
      CMAX(5)=ZO(1)
      CMAX(6)=ZO(1)

      DO I=1,NNODE
       IF (XO(I).GE.CMAX(1)) CMAX(1)=XO(I)
       IF (XO(I).LE.CMAX(2)) CMAX(2)=XO(I)
       IF (YO(I).GE.CMAX(3)) CMAX(3)=YO(I)
       IF (YO(I).LE.CMAX(4)) CMAX(4)=YO(I)
       IF (ZO(I).GE.CMAX(5)) CMAX(5)=ZO(I)
       IF (ZO(I).LE.CMAX(6)) CMAX(6)=ZO(I)
       ZO(I)=-ZO(I)
       XP(I)=XO(I)*CA(1)+YO(I)*CB(1)+ZO(I)*CG(1)
       YP(I)=XO(I)*CA(2)+YO(I)*CB(2)+ZO(I)*CG(2)
       ZO(I)=-ZO(I)
      END DO

      RETURN
      END
```

```
      SUBROUTINE SFRCIN (L,ND,XC,YC,ZC,IX,E,UD,FINT,STRS,STRAIN,STRESS,N
     1UMEL,INDEX,SMASS,EUI,EUJ,TRAI,TRAJ,EH,AL,IEIGEN,INMESH)
Cbrc
Cbrc IT APPEARS THIS SUBROUTINE NEVER GETS CALLED!
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... THIS ROUTINE CALCULATES THE INTERNAL FORCE IN AN AXIAL 3-D SPRING
C.... AND TRANSFERS THE FORCE AND MOMENT DUE TO THE SPRING FORCE TO
C.... THE ASSOCIATED RIGIB BODY
C.... TRAI AND TRAJ CONTAIN R-ZERO AND R-ZERO-BAR FOR NODES I & J
C
      COMMON/ALINE/NS,LEL(40),UCP(120),OMEGA(360),EUL(360)
      INCLUDE 'ADJUST.COM'
      INCLUDE 'MATRIX.COM'
      INCLUDE 'NUMINT.COM'
      INCLUDE 'CONTRL.COM'

      DOUBLE PRECISION FINT(NFINT)

      DIMENSION XC(NXC), YC(NYC), ZC(NZC), IX(14,NIX), E(12,NE), UD(NX1)
     1        ,STRAIN(NSTRAI), STRESS(NSTRES), STRS(NSTRS), INDEX(
     2        NINDEX), EUI(9), EUJ(9), TRAI(6), TRAJ(6), EH(3), OMEGI(
     3        3,3), OMEGJ(3,3), TEMP1(3), TEMP2(3), TEMP3(3), TEMP4(3)
     4        ,AL(NAL), DISP(2), SMASS(NSMASS), INMESH(NINMEH)
C
      IF(KONTRL(16).EQ.0) GO TO 30
C
C CHECK IF ELEMENT L IS AN ELEMENT ASSOCIATED WITH THE RIGHT OR LEFT
C SHOULDER RIGID BODIES OR RIBS.
C
      ISET=0
      NAM = 3*3
      NB = 3*1
      NR = 3*1
Cbrc
Cbrc NOTE: WHERE IS NS SET? SINCE THIS SUBROUTINE ISN'T CALLED, WE'RE
Cbrc NOT SURE. BROWSER SHOWS THAT THE COMMON BLOCK ISN'T USED ANYWHERE
Cbrc ELSE.
Cbrc
      DO 31 I=1,NS
      IF(L.NE.LEL(I)) GO TO 31
      ISET=1
      IND=I
   31 CONTINUE
C
   30 N1=IX(1,L)
      N2=IX(2,L)
      N3=IX(3,L)
      N4=IX(4,L)
C
      ISKIP=0
      JSKIP=0
C
C.... CHECK FOR PRIMARY OR SECONDARY NODES
C
      IF (N3.EQ.N1) ISKIP=1
      IF (N4.EQ.N2) JSKIP=1
C
C.... SET UP OMEGA TRANSFORMATION MATRICES
C
      IF (ISKIP.EQ.1) GO TO 1
      OMEGI(1,1)=0.
      OMEGI(1,2)=TRAI(6)
      OMEGI(1,3)=-TRAI(5)
      OMEGI(2,1)=-TRAI(6)
      OMEGI(2,2)=0.
      OMEGI(2,3)=TRAI(4)
      OMEGI(3,1)=TRAI(5)
      OMEGI(3,2)=-TRAI(4)
      OMEGI(3,3)=0.
    1 IF (JSKIP.EQ.1) GO TO 2
      OMEGJ(1,1)=0.
      OMEGJ(1,2)=TRAJ(6)
      OMEGJ(1,3)=-TRAJ(5)
      OMEGJ(2,1)=-TRAJ(6)
```

```
      OMEGJ(2,2)=0.D0
      OMEGJ(2,3)=TRAJ(4)
      OMEGJ(3,1)=TRAJ(5)
      OMEGJ(3,2)=-TRAJ(4)
      OMEGJ(3,3)=0.D0
C
      IF(KONTRL(16).EQ.0) GO TO 32
      IF(ISET.EQ.0) GO TO 32
      N=9*(IND-1)+1
      K=1
      DO 33 J=1,3
      DO 33 I=1,3
      OMEGA(N)=OMEGJ(I,J)
      EUL(N)=EUJ(K)
      N=N+1
   33 K=K+1
   32 CONTINUE
C.... TRANSFORM R-ZERO-BAR TO GLOBAL SYSTEM
C
    2 IF (ISKIP.EQ.1) GO TO 3
      TEMP1(1)=TRAI(4)
      TEMP1(2)=TRAI(5)
      TEMP1(3)=TRAI(6)
    3 IF (JSKIP.EQ.1) GO TO 4
      TEMP2(1)=TRAJ(4)
      TEMP2(2)=TRAJ(5)
      TEMP2(3)=TRAJ(6)
    4 IF (ISKIP.EQ.1) GO TO 5
      CALL GMPRD (EUI,TEMP1,TEMP3,3,3,1)
    5 IF (JSKIP.EQ.1) GO TO 6
      CALL GMPRD (EUJ,TEMP2,TEMP4,3,3,1)
C
C.... DETERMINE SECONDARY NODE GLOBAL DISPLACEMENTS
C
    6 XX=XC(N2)-XC(N1)
      YY=YC(N2)-YC(N1)
      ZZ=ZC(N2)-ZC(N1)
      N1N=(N1-1)*ND
      N2N=(N2-1)*ND
      N3N=(N3-1)*ND
      N4N=(N4-1)*ND
      IF (ISKIP.EQ.1) GO TO 7
      DIX=UD(N3N+1)+TEMP3(1)-TRAI(1)
      DIY=UD(N3N+2)+TEMP3(2)-TRAI(2)
      DIZ=UD(N3N+3)+TEMP3(3)-TRAI(3)
      UD(N1N+1)=DIX
      UD(N1N+2)=DIY
      UD(N1N+3)=DIZ
      GO TO 8
    7 DIX=UD(N3N+1)
      DIY=UD(N3N+2)
      DIZ=UD(N3N+3)
    8 IF (JSKIP.EQ.1) GO TO 9
      DJX=UD(N4N+1)+TEMP4(1)-TRAJ(1)
      DJY=UD(N4N+2)+TEMP4(2)-TRAJ(2)
      DJZ=UD(N4N+3)+TEMP4(3)-TRAJ(3)
C
      IF(KONTRL(16).EQ.0) GO TO 34
      IF(ISET.EQ.0) GO TO 34
      M=3*(IND-1)+1
      UCP(M)=DJX
      UCP(M+1)=DJY
      UCP(M+2)=DJZ
   34 CONTINUE
C
      UD(N2N+1)=DJX
      UD(N2N+2)=DJY
      UD(N2N+3)=DJZ
      GO TO 10
    9 DJX=UD(N4N+1)
      DJY=UD(N4N+2)
      DJZ=UD(N4N+3)
   10 IF (IEIGEN.EQ.1) GO TO 19
C
C.... DETERMINE ELEMENT STRAIN
C
```

```
      DIJX=DJX-DIX
      DIJY=DJY-DIY
      DIJZ=DJZ-DIZ
      DX=XX+DIJX
      DY=YY+DIJY
      DZ=ZZ+DIJZ
      AL2=AL(L)*AL(L)
      FAC=2.D0*(XX*DIJX+YY*DIJY+ZZ*DIJZ)+DIJX*DIJX+DIJY*DIJY+DIJZ*DIJZ
      ALN2=AL2+FAC
      ALN=DSQRT(ALN2)
      STREH=FAC/(AL(L)+ALN)/AL(L)
C
C.... DETERMINE NEW DIRECTION COSINES OF ELEMENT    MU=EH
C
      EH(1)=DX/ALN
      EH(2)=DY/ALN
      EH(3)=DZ/ALN
C
C.... DETERMINE LOCAL INTERNAL FORCES
C
      DISP(1)=ALN
      DISP(2)=STREH
      MTYP=IX(9,L)
      I1=1
      NOPT=IX(10,L)
      CALL LOCFRC (L,DISP,TEMP1,TEMP2,TEMP3,E,INDEX,I1,STRAIN,STRESS,STR
     1S,SMASS,IX,AL(L),MTYP,NOPT,NUMEL,ZC,INMESH)
      FIXH=TEMP2(1)
      FJXH=TEMP2(2)
C
C.... IF(FIXH.NE.0.) WRITE(6,201) L,FIXH
C.... IF(FJXH.NE.0.) WRITE(6,202) L,FJXH
C
      IF (FJXH.EQ.0.) GO TO 19
C
C.... ACCUMULATE INTERNAL ELEMENT FORCE IN  FINT  IN GLOBAL SYSTEM
C
      DO 11 M=1,3
        TEMP1(M)=EH(M)*FIXH
        TEMP2(M)=EH(M)*FJXH
        FINT(N3N+M)=FINT(N3N+M)+TEMP1(M)
   11   FINT(N4N+M)=FINT(N4N+M)+TEMP2(M)
C
C.... ACCUMULATE MOMENT DUE TO INTERNAL FORCE IN  FINT  IN BODY SYSTEM
C
      IF (ISKIP.EQ.1) GO TO 12
      CALL GTPRD (EUI,TEMP1,TEMP3,3,3,1)
      CALL GTPRD (OMEGI,TEMP3,TEMP1,3,3,1)
      GO TO 14
   12 DO 13 M=1,3
   13  TEMP1(M)=0.D0
   14 IF (JSKIP.EQ.1) GO TO 15
      CALL GTPRD (EUJ,TEMP2,TEMP4,3,3,1)
      CALL GTPRD (OMEGJ,TEMP4,TEMP2,3,3,1)
      GO TO 17
   15 DO 16 M=1,3
   16  TEMP2(M)=0.D0
   17 I=0
      DO 18 M=4,6
       I=I+1
       FINT(N3N+M)=FINT(N3N+M)+TEMP1(I)
   18  FINT(N4N+M)=FINT(N4N+M)+TEMP2(I)
   19 RETURN
C
      END
```

```
      SUBROUTINE SLIDER (NOP,FINT,SMASS,UD2,UD,TIME,NCP,NASN,INMESH,
     2DICOS,ALPHA,UP,UP2,NPNO,SEATK,UPOLD,SEATWK,SEATEX,UD1,UP1,VDAMP)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      INCLUDE 'MATRIX.COM'
      INCLUDE 'CONTRL.COM'
      COMMON /SEATM/ USEAT,VSEAT,ASEAT
      DIMENSION NCP(10,NNCP), X1(3), X2(3), X3(3), V1(3), V2(3), UP2(
     1        NUP2), UD2(NAO), ALPHA(3,3,NALPHA), UD(NX1),
     2        UP(NUP), NASN(NNASN), INMESH(NINMEH), DICOS(3,NDICOP),
     3        NPNO(NNPNO), SEATK(2,NSEATK), UPOLD(NUPOLD), UD1(NVO),
     4        UP1(NUP1), VDAMP(NVDAMP)
      DIMENSION SMASS(NSMASS)
      DOUBLE PRECISION FINT(NFINT)
C
      DIMENSION DELTY0(50)
C
C DELTY0 IS THE ARRAY OF INITIAL DISTANCES FROM THE SEATBACK
C
      IF (TIME.GT.0.) GO TO 9
C
      DO 7 I=1,NOP
       READ (5,901) NPNO(I),NASN(I),(DICOS(J,I),J=1,3),(SEATK(J,I),J=1,
     1 2),VDAMP(I)
       IF (NASN(I).GT.0) GO TO 1
       READ (5,902) (NCP(J,I),J=1,2)
       GO TO 2
    1  ISTOP=NASN(I)
       READ (5,902) (NCP(J,I),J=1,ISTOP)
    2  READ (5,903) (X1(J),J=1,3),(X2(J),J=1,3),(X3(J),J=1,3)
       WRITE (6,904) NPNO(I),NASN(I)
       WRITE (6,905) (DICOS(J,I),J=1,3)
       WRITE (6,906) (SEATK(J,I),J=1,2),VDAMP(I)
       WRITE (6,907)
       IF (NASN(I).GT.0) GO TO 3
       WRITE (6,902) (NCP(J,I),J=1,2)
       GO TO 4
    3  ISTOP=NASN(I)
       WRITE (6,902) (NCP(J,I),J=1,ISTOP)
    4  WRITE (6,908) (X1(J),J=1,3),(X2(J),J=1,3),(X3(J),J=1,3)
C
C
C IF REQUIRED, READ IN THE INITIAL DISTANCES FROM THE SEATBACK OF
C NODES WHICH MAY CONTACT SEATBACK. IT IS ASSUMED THAT THE PLANE I = 1
C IS THE SEATBACK.
C
      IF(I.GT.1) GO TO 1007
      IF(KONTRL(14).EQ.1) GO TO 1002
      DO 1001 KK=1,50
 1001 DELTY0(KK)=0.
      GO TO 1007
 1002 IF(NASN(I).GT.0) GO TO 1003
      NCONT=NCP(2,I)-NCP(1,I)+1
      GO TO 1004
 1003 NCONT=NASN(I)
 1004 READ(5,1005) (DELTY0(KK),KK=1,NCONT)
 1005 FORMAT(8F10.3)
      WRITE(6,1006) (DELTY0(KK),KK=1,NCONT)
 1006 FORMAT('0 ARRAY OF INITIAL DISTANCES FROM SEATBACK'/(10F10.3))
C
 1007 T1MAG=0.
       DO 5 J=1,3
        V1(J)=X2(J)-X1(J)
        T1MAG=T1MAG+V1(J)*V1(J)
    5   V2(J)=X3(J)-X1(J)
       UN1=V1(2)*V2(3)-V2(2)*V1(3)
       UN2=V1(3)*V2(1)-V2(3)*V1(1)
       UN3=V1(1)*V2(2)-V2(1)*V1(2)
       UNMAG=SQRT(UN1*UN1+UN2*UN2+UN3*UN3)
       T1MAG=SQRT(T1MAG)
       ALPHA(1,1,I)=UN1/UNMAG
       ALPHA(1,2,I)=UN2/UNMAG
       ALPHA(1,3,I)=UN3/UNMAG
C
```

```
C....  REPLACE MESH NODE NO. WITH INTERNAL NODE NO.
C
      ISTOP=NASN(I)
      NPNO(I)=INMESH(NPNO(I))
      IF (ISTOP.EQ.0) ISTOP=2
      DO 6 LEN=1,ISTOP
       NMESH=NCP(LEN,I)
   6   NCP(LEN,I)=INMESH(NMESH)
      WRITE (6,909)
      WRITE (6,902) (NCP(LEN,I),LEN=1,ISTOP)
C
   7  CONTINUE
C
     K=3*NOP
     DO 8 J=1,K
      UP(J)=0.
      UP1(J)=0.
   8  UP2(J)=0.
     RETURN
C
   9 SEATWK=0.D0
     SEATEX=0.D0
C
C TEMP MOD 7-6-84 - NO CALLS TO ICIF FROM SLIDER - SEAT MOTION, GIVEN
C BY USEAT,VSEAT AND ASEAT, OBTAINED FROM FREEFD THROUGH
C COMMON/ SEATM /
C
C     IF(KONTRL(13).EQ.0) GO TO 10
C     CALL ICIF (TIME,ASEAT,0)
C     CALL ICIF (TIME,VSEAT,1)
C     CALL ICIF (TIME,USEAT,2)
C  10 DO 13 I=1,NOP
C
  10 DO 13 I=1,NOP
      KN=6*(NPNO(I)-1)
      DO 12 J=1,3
       K=3*(I-1)+J
       UPOLD(K)=UP(K)
       UP2(K)=ASEAT*DICOS(J,I)
       UP1(K)=VSEAT*DICOS(J,I)
       UP(K)=USEAT*DICOS(J,I)
  12    UD(KN+J)=UP(K)
  13   CONTINUE
C
     DO 22 I=1,NOP
C
      ISKIP=0
      IF (NASN(I).EQ.0) GO TO 14
      ISTART=1
      IEND=NASN(I)
      ISKIP=1
      GO TO 15
  14  ISTART=NCP(1,I)
      IEND=NCP(2,I)
  15  K=3*(I-1)
     IABE=0
      DO 22 J=ISTART,IEND
     IABE=IABE+1
      NN=J
      IF (ISKIP.EQ.1) NN=NCP(J,I)
      KN=6*(NN-1)
      DELTND=0.
     DELTND=DELTND+DELTY0(IABE)
     ABE=DELTND
      VELNOR=0.
      ACCNOR=0.
      DO 16 L=1,3
       ACCNOR=ACCNOR+(UD2(KN+L)-UP2(K+L))*ALPHA(1,L,I)
       VELNOR=VELNOR+(UD1(KN+L)-UP1(K+L))*ALPHA(1,L,I)
  16    DELTND=DELTND+(UD(KN+L)-UP(K+L))*ALPHA(1,L,I)
      IF (DELTND.GT.0.) GO TO 22
     IF(VELNOR.GT.0.) GO TO 22
      KP=6*(NPNO(I)-1)
      SEATF=(SEATK(1,I)+SEATK(2,I)*DELTND*DELTND)*DELTND
      IF(KONTRL(8).EQ.1) GO TO 17
      FDAMP=2.0D0*VDAMP(I)*DSQRT(SEATK(1,I)*SMASS(KN+1))*VELNOR
```

```
   GO TO 18
 17  FDAMP=VDAMP(I)*SEATK(1,I)*VELNOR
 18  SEATF=SEATF+FDAMP
     DO 20 L=1,3
      SEATEX=SEATEX-(SEATF+SMASS(KN+L)*ACCNOR)*(UP(K+L)-UPOLD(K+L))*
  1   ALPHA(1,L,I)
      FINT(KP+L)=FINT(KP+L)-SEATF*ALPHA(1,L,I)
 20    FINT(KN+L)=FINT(KN+L)+SEATF*ALPHA(1,L,I)
C....  19 FORCD(KN+L)=FORCD(KN+L) + V2(L)
C
     SEATWK=SEATWK+SEATF*DELTND
 22  CONTINUE
    RETURN
901 FORMAT (2I5,6E10.0)
902 FORMAT (10I5)
903 FORMAT (3E10.0)
904 FORMAT (/,5X,5HPLANE,I5,5X,28HNO OF ASSOCIATED SPACE NODES,I5)
905 FORMAT (10X,17HDIRECTION COSINES,10X,8HX - AXIS,12X,8HY - AXIS,12X
  1,8HZ - AXIS,/,28X,1P3E20.4)
906 FORMAT (5X,36HELASTIC SEATBACK STIFFNESS   LINEAR=,1PE15.4,10X,6HC
  1UBIC=,1PE15.4,10X,14HDAMPING COEF =,1PE12.4)
907 FORMAT (5X,22HASSOCIATED SPACE NODES)
908 FORMAT (5X,25HPLANE NODES X1,X2, AND X3,12X,11HX-COMPONENT,9X,11HY
  1-COMPONENT,9X,11HZ-COMPONENT,/,30X,2HX1,1P3E20.4,/,30X,2HX2,1P3E20
  2.4,/,30X,2HX3,1P3E20.4,/)
909 FORMAT (5X,43HINTERNAL NODE NO. OF ASSOCIATED SPACE NODES)
910 FORMAT (3(5X,1P3E20.4,/),3X,1P6E20.4)
911 FORMAT (10X,1P6E20.4)
    END
```

```
      SUBROUTINE SOLVE (NODDIS,SMASS,XC,YC,ZC,IX,E,XO,X1,V,AO,A1,FORCD,F
     1INT,EULCO,DICOS,INMESH,AL,INDEX,STRS,STRAIN,STRESS,IPT,FEXOLD,
     2NCP,NASN,DICOSP,ALPHA,UP,UP2,NPNO,SEATK,UPOLD,VDAMP,UP1,VOLD)

      IMPLICIT DOUBLE PRECISION (A-H,O-Z)

      INCLUDE 'ADJUST.COM'
      INCLUDE 'SIZE.COM'
      INCLUDE 'CONTRL.COM'
      INCLUDE 'DYNAM.COM'
      INCLUDE 'OUTPA.COM'
      INCLUDE 'ARRAY.COM'
      INCLUDE 'INDEX.COM'
      DOUBLE PRECISION FINT(NFINT)
      DIMENSION XO(NXO), X1(NX1), V(NVO), AO(NAO), A1(NA1), FORCD(
     1      NFORCD), NODDIS(NNODIS), SMASS(NSMASS), XC(NXC), YC(
     2      NYC), IX(14,NIX), E(12,NE), JJ(7), AT(3), DICOS(9,
     3      NDICOS), INMESH(NINMEH), ZC(NZC), EULCO(3,3,NBLAMB)
      DIMENSION INDEX(NINDEX), STRS(NSTRS), STRAIN(NSTRAI), STRESS(
     1      NSTRES), AL(NAL), FEXOLD(NFEXOD), NCP(10,NNCP), NASN(
     2      NNASN), DICOSP(3,3,NDICOP), ALPHA(3,3,NALPHA), UP(NUP),
     3      UP2(NUP2), NPNO(NNPNO), SEATK(2,NSEATK), UPOLD(NUPOLD),
     4      UP1(NUP1), VDAMP(NVDAMP), IPT(NIPT)
      DIMENSION VOLD(NVOLD)
      DIMENSION ABIRD(600),VBIRD(600)
C
C.... DIMENSION STATEMENT NEEDED FOR EXTERNAL ENERGY CALCULATION
C.... WHEN PRESCRIBED DEGREES OF FREEDOM ARE USED (20 P.D.O.F.)
C
      DIMENSION XPRED(20), ITPD(20), FROLD(20)
C
C....   CONTROL VARIABLES FOR INTEGRATION
C
      ICON=0
      NSLIDP=KONTRL(4)
      BETA=KONTRL(5)
      IB=KONTRL(6)*6
      MEQ=NUMNP*NDGREE
      NEQ=NPRI*NDGREE
      IEIGEN=0
      SEATWK=0.D0
      SEATEX=0.D0
      IF (BETA.NE.0.) GO TO 54
C
C....   ZERO DEPENDENT VARIABLES
C
      DO KK=1,20
       XPRED(KK)=0.D0
       FROLD(KK)=0.D0
      END DO
      DO I=1,MEQ
       XO(I)=0.D0
       X1(I)=0.D0
      END DO
      IND=INDEX(NELE+1)-1
      IEND=NUMMAT+2
      LLSTRS=IND+IEND
      WRITE (6,901) LLSTRS
      DO M=1,IEND
       N=IND+M
       STRS(N)=0.D0
      END DO
C
C.... COMPUTE INTEGRATION PARAMETERS
C
      TIME=0.D0
      NTSTEP=0
      C1=(.5D0-BETA)*DELT*DELT
      C2=BETA*DELT*DELT
      C3=DELT/2.D0
C
C....     INITIAL CONDITIONS
C
      CALL FREEFD (2,NUMDIS,NODDIS,NUMNP,NDGREE,XC,YC,ZC,X1,V,AO,FORCD,I
     1NMESH,BETA)
C
```

```
C.... CALCULATE INITIAL KINETIC ENERGY
C
      UKE=0.D0
      DO LES=1,NEQ
       UKE=UKE+SMASS(LES)*V(LES)*V(LES)
      END DO
      IEE=INDEX(NELE+1)+NUMMAT+1
      STRS(IEE)=.5D0*UKE
C
      IF (NSLIDP.NE.0)
     1 CALL SLIDER (NSLIDP,FINT,SMASS,A1,X1,TIME,NCP,NASN,
     2         INMESH,DICOSP,ALPHA,UP,UP2,NPNO,SEATK,UPOLD,
     3         SEATWK,SEATEX,V,UP1,VDAMP)
      CALL UPDATE ( NPRI,NDGREE,DELT,X1,XO,V,A1,EULCO(1,1,1),BETA )
      CALL FRCIN (NELE,NDGREE,XC,YC,ZC,IX,E,X1,FINT,STRS,
     1        STRAIN,STRESS,IPT,INDEX,EULCO,SMASS,DICOS,NPRI,
     2        AL,IEIGEN,INMESH)
      WRITE (6,902)
      WRITE (6,903) (LEN,AL(LEN),LEN=1,NELE)
      GO TO 7
      ENTRY RESOLV
      BETA=KONTRL(5)
      MEQ=NUMNP*NDGREE
      NEQ=NPRI*NDGREE
      IEIGEN=0
      NSLIDP=KONTRL(4)
      SEATWK=0.D0
      SEATEX=0.D0
      C1=(.5D0-BETA)*DELT**2
      C2=BETA*DELT*DELT
      C3=DELT*.5D0
C
C....   INTEGRATION LOOP
C
    7 ITER=0
      NTSTEP=NTSTEP+1
      TIME=TIME+DELT
      DO I=1,NEQ
       FORCD(I)=0.D0
       A1(I)=AO(I)
      END DO
      CALL FREEFD (1,NUMDIS,NODDIS,NUMNP,NDGREE,XC,YC,ZC,X1,V,AO,
     1        FORCD,INMESH,BETA)
      ITER=ITER+1
C
C.... ALTER PRESCRIBED DISPLACEMENTS
C....   ZERO ALL ACC. AND VEL. CORRESPONDING TO PRESCRIBED DISPLACEMENT
C
      NPDOF=0
      IF (NUMDIS.LE.0) GO TO 18
      DO I=1,NUMDIS
       CALL DECOD (NODDIS(I),JJ,3,7)
       J7=JJ(7)
       ML=NDGREE*(J7-1)
       DO 14 J=1,NDGREE
        ML=ML+1
        IF (JJ(J)-1) 14,12,11
   11   NPDOF=NPDOF+1
        XPRED(NPDOF)=XO(ML)
        XO(ML)=X1(ML)
        ITPD(NPDOF)=ML
        GO TO 13
   12   X1(ML)=0.D0
        XO(ML)=0.D0
   13   V(ML)=0.D0
        AO(ML)=0.D0
        A1(ML)=0.D0
        ABIRD(ML) = 0.D0
        VBIRD(ML) = 0.D0
        FORCD(ML)=0.D0
   14   CONTINUE
      END DO
C
C....   COMPUTE NEW DISPLACEMENTS
C
   18 I=0
```

```
 19 I=I+1
   IF (I.LE.NEQ) THEN
    IF (SMASS(I).NE.0.) THEN
     X1(I)=XO(I)+V(I)*DELT+C1*AO(I)
     GO TO 19
    END IF
    I=I+5
    GO TO 19
   END IF
C
   CALL UPDATE (NPRI,NDGREE,DELT,X1,XO,V,A1,EULCO,BETA)
   CALL FRCIN (NELE,NDGREE,XC,YC,ZC,IX,E,X1,FINT,STRS,
   1        STRAIN,STRESS,IPT,INDEX,EULCO,SMASS,DICOS,NPRI,AL,
   2        IEIGEN,INMESH)
   IF (NSLIDP.NE.0)
   1 CALL SLIDER (NSLIDP,FINT,SMASS,A1,X1,TIME,NCP,NASN,
   2          INMESH,DICOSP,ALPHA,UP,UP2,NPNO,SEATK,UPOLD,
   3          SEATWK,SEATEX,V,UP1,VDAMP)

   MJ=0
 23 DO I=1,3
    IF (SMASS(I+MJ).EQ.0.) GO TO 26
    A1I=(FORCD(I+MJ)-FINT(I+MJ))/SMASS(I+MJ)
    A1(I+MJ)=A1I
   END DO
   M1=MJ+4
   M2=MJ+5
   M3=MJ+6
   M4=MJ+3
   AT(1)=(FORCD(M1)-FINT(M1)+(SMASS(M2)-SMASS(M3))*V(M2)*V(M3))
   1     /SMASS(M1)
   AT(2)=(FORCD(M2)-FINT(M2)+(SMASS(M3)-SMASS(M1))*V(M3)*V(M1))
   1     /SMASS(M2)
   AT(3)=(FORCD(M3)-FINT(M3)+(SMASS(M1)-SMASS(M2))*V(M1)*V(M2))
   1     /SMASS(M3)
   DO I=1,3
    A1(M4+I)=AT(I)
   END DO
 26 MJ=MJ+NDGREE
   IF (MJ.LT.NEQ) GO TO 23

   DO I=1,NEQ
    VOLD(I)=V(I)
    V(I)=V(I)+C3*(A1(I)+AO(I))
    AO(I)=A1(I)
   END DO
C
C.... COMPUTE KINETIC ENERGY AND EXTERNAL ENERGY
C
   IKE=INDEX(NELE+1)
   IEE=IKE+NUMMAT+1
   STRS(IKE)=0.D0
   I=0
 36 I=I+1
   IF (I.GT.NEQ) GO TO 38
   IF (SMASS(I).EQ.0.) GO TO 37
   STRS(IKE)=STRS(IKE)+SMASS(I)*V(I)*V(I)
   GO TO 36
 37 I=I+5
   GO TO 36
C
C.... CORRECT KINETIC ENERGY AND ADD EXTERNAL ENERGY FOR
C.... PRESCRIBED DISPLACEMENT DEGREES OF FREEDOM
C
 38 IF (NPDOF.EQ.0) GO TO 41
   DO KK=1,NPDOF
    ML=ITPD(KK)
    STRS(IKE)=STRS(IKE)-SMASS(ML)*V(ML)*V(ML)
   END DO
   CALL FREEFD (3,NUMDIS,NODDIS,NUMNP,NDGREE,XC,YC,ZC,X1,V,A1,
   1       FORCD,INMESH,BETA)
   DO KK=1,NPDOF
    ML=ITPD(KK)
    STRS(IKE)=STRS(IKE)+SMASS(ML)*V(ML)*V(ML)
    FRACT=FINT(ML)+SMASS(ML)*A1(ML)
    STRS(IEE)=STRS(IEE)+.5D0*(FRACT+FROLD(KK))*(X1(ML)-XPRED(KK))
```

```
      FROLD(KK)=FRACT
     END DO
C
C.... CALCULATION OF EXTERNAL ENERGY WHEN SLIDING INTERFACES ARE USED
C
  41 IF (NSLIDP.EQ.0) GO TO 51
     DO 50 LS=1,NSLIDP
      ISKIP=0
      IF (NASN(LS).EQ.0) GO TO 42
      ISTART=1
      IEND=NASN(LS)
      ISKIP=1
      GO TO 43
  42  ISTART=NCP(1,LS)
      IEND=NCP(2,LS)
  43  DO 49 J=ISTART,IEND
       NN=J
       IF (ISKIP.EQ.1) NN=NCP(J,LS)
C
C....  CHECK FOR NODES WHOSE MOTION IS PRESCRIBED BY MORE THAN
C....  ONE PLANE
C
       IF (LS.EQ.1) GO TO 47
       NCHECK=LS-1
       DO 46 LEN=1,NCHECK
        IF (NASN(LEN).EQ.0) GO TO 45
        JSTART=1
        JEND=NASN(LEN)
        DO LL=JSTART,JEND
         NKK=NCP(LL,LEN)
         IF (NN.EQ.NKK) GO TO 49
        END DO
        GO TO 46
  45     NSTART=NCP(1,LEN)
        NEND=NCP(2,LEN)
        IF (NN.GE.NSTART.AND.NN.LE.NEND) GO TO 49
  46     CONTINUE
C
  47   KDOF=6*(NN-1)
       DO LES=1,3
        ML=KDOF+LES
        FORCD(ML)=FINT(ML)+SMASS(ML)*AO(ML)
       END DO
  49   CONTINUE
  50  CONTINUE
C
  51 STRS(IKE)=.5D0*STRS(IKE)+.5D0*SEATWK
C
     WRKEXT=SEATEX
     DO KK=1,NEQ
      WRKEXT=WRKEXT+(FORCD(KK)+FEXOLD(KK))*(X1(KK)-XO(KK))
      FEXOLD(KK)=FORCD(KK)
      XO(KK)=X1(KK)
     END DO
C
     STRS(IEE)=STRS(IEE)+.5D0*WRKEXT
     NWRKP=MOD(NTSTEP,NPFREQ)
     IF (NWRKP.NE.0) GO TO 53
     IF (NSLIDP.EQ.0) GO TO 53
     WRITE (6,904) SEATWK,SEATEX
  53 CONTINUE
C
     IF(NTSTEP.GT.1) GO TO 58
     NANG=(LUOUT-LDEF)/4
     IF (NANG.EQ.0) THEN
     AM = 0
     ELSE
     AM=DFLOAT(NAN/NANG)
     END IF
     NAN=NANG
58   CONTINUE
     IF(ICON.EQ.1) GO TO 70
     DO KK=1,NEQ
      VBIRD(KK)=V(KK)
      ABIRD(KK)=A1(KK)
     END DO
```

```
70  CONTINUE
    CALL OUTPUT(Q(LXC),Q(LYC),Q(LZC),Q(LIX),Q(LX1),
   1        VBIRD,ABIRD,NUMNP,NPRI,NELE,NDGREE,NUMMAT,
   2        Q(LINDEX),STRS,Q(LBLAMB),Q(LMESHN),Q(LINMEH),
   3        Q(LUOUT),Q(LSOUT),Q(LNPOUT),Q(LGLABE),Q(LUU),Q(LSS),
   4        Q(LT),Q(LA),Q(LPSU),Q(LNTYPE),Q(LAUX),Q(LIPT),AM)
    IF (NTSTEP.LT.MXSTEP) GO TO 7
C
C....   END OF LOOP
C
    RETURN
 54 WRITE (6,905) BETA

    STOP
C
 901 FORMAT (/,5X,23HLENGTH OF  STRS  ARRAY=,I5)
 902 FORMAT (/,10X,23HORGINAL ELEMENT LENGTHS,/)
 903 FORMAT(5(5X,I5,5X,D10.3))
 904 FORMAT (5X,10HSEAT INWK=,1PD12.4,5X,10HSEAT EXWK=,1PD12.4)
 905 FORMAT (1H0, 5X, 'BETA = ', D15.6)
 911 FORMAT ( 16I5 )
    END
```

```
      SUBROUTINE SPINIF(JE,JSTART,JEND,NB,FORCE,BMOMT,ZC,NZC,INMESH,
     1              NINMEH)
C
C     PERKIN - ELMER VERSION
C
C     REPLACES PREVIOUS HSM SPINAL INJURY PREDICTION POSTPROCESSOR,
C     INJCRI
C
C     SPINIF DETERMINES THE SPINAL INJURY FUNCTION,
C     SIF = FUNCTION( COMPUTED AXIAL COMPRESSION AND BENDING MOMENTS
C               PLUS YIELD CRITERIA BASED, IN PART,ON EXPERIMEN-
C               TALLY MEASURED VERTEBRAL LOAD-DEFORMATION DATA )
C
C     JE = ELEMENT NUMBER
C     JSTART = INFERIOR DISC ELEMENT FOR BOTTOM MOST VERTEBRAL LEVEL
C          CONSIDERED
C     JEND = SUPERIOR ELEMENT FOR UPPERMOST VERTEBRAL LEVEL CONSIDERED
C     NB = NO. VERTEBRAL LEVELS CONSIDERED
C     FORCE = ELEMENT JE LOCAL NODAL FORCE ARRAY
C     BMOMT = ELEMENT JE LOCAL NODAL MOMENT ARRAY
C
C     PY,BMYY,BMZY = AXIAL COMPRESSION, LATERAL BENDING MOMENT AND
C              A-P BENDING MOMENT, RESPECTIVELY, CORRESPONDING
C              TO YIELDING OF THE CORTICAL SHELL
C     ISYM = SYMMETRY OPTION
C        = 0, SIMULATION IS SYMMETRIC ABOUT GLOBAL YZ PLANE
C
C     ALL LOADS ARE SAMPLED EVERY NPFREQ STEPS, WITH A SAMPLED VALUE
C     COMPUTED AS THE MEAN OF ALL VALUES DURING A SAMPLING INTERVAL,
C     AND TAKEN TO OCCUR AT THE MIDPOINT OF THE INTERVAL.
C
C     AUGUST - 1983
C
      IMPLICIT DOUBLE PRECISION(A-H,O-Z)
C
      DIMENSION FORCE(6),BMOMT(6),PY(20),BMYY(20),BMZY(20),Z(20),
     1      ZC(NZC),INMESH(NINMEH),PE(20),VYE(20),VZE(20),TE(20),
     2 BMYE(20),BMZE(20),PSUM(20),VYSUM(20),VZSUM(20),TSUM(20),BMYSUM
     3      (20),BMZSUM(20),P(20),VY(20),VZ(20),T(20),BMY(20),BMZ
     4      (20),TP(20),TVY(20),TVZ(20),TT(20),TMY(20),TMZ(20),F1
     5      (20),PF1(20),BMF1(20),TF1(20),F2(20),PF2(20),BMF2(20),
     6      TF2(20),F(20),PF(20),BMF(20),TF(20),TEMP(20),ZLABEL
     7      (10),PLOT1(10),PLOT2(10),PLOT3(10),PLOT4(10),PLOT5(10)
     8      ,PLOT6(10),PLOT7(10),PLOT8(10),PLOT9(10)
      DIMENSION TEA(20),BMYEA(20),BMZEA(20),VZEA(20),VYEA(20),FA(20)    RVCC
C
      COMMON/DYNAM/DELT,TIMEND,MXSTEP,NTSTEP,TIME
      COMMON/OUTPA/NPRU,NPRS,NPFREQ
      COMMON/CONTRL/KONTRL(16)                          RVCC
C
      DATA N1/1/
      DATA ZLABEL/4HVERT, 4HEBRA, 4HL LE, 4HVEL , 6*4H    /
      DATA PLOT1/4H P / , 4HPY  , 8*4H    /
      DATA PLOT2/4HBMY , 4H/ BM, 4HYY  , 7*4H    /
      DATA PLOT3/4HBMZ , 4H/ BM, 4HZY  , 7*4H    /
      DATA PLOT4/4HVY  , 9*4H    /
      DATA PLOT5/4HVZ  , 9*4H    /
      DATA PLOT6/4HT   , 9*4H    /
      DATA PLOT7/4H" SA, 4HGITT, 4HAL ", 4H PLA, 4HNE I, 4HNJUR,
     1        4HY FU, 4HNCTI, 4HON  , 4H    /
      DATA PLOT8/4H" FR, 4HONTA, 4HL " , 4HPLAN, 4HE IN, 4HJURY,
     1        4H FUN, 4HCTIO, 4HN   , 4H    /
      DATA PLOT9/4H* * , 4H* SP, 4HINAL, 4H INJ, 4HURY , 4HFUNC,
     1        4HTION, 4H * *, 4H *  , 4H    /
C
C
C     INITIALIZATION
C
      N2=N1*NPFREQ
      IF(TIME.GE.DELT) GO TO 30
      IF(JE.GT.JSTART) GO TO 40
      WRITE(6,2000)
 2000 FORMAT(1H1,51H - - - SPINIF ( SPINAL INJURY FUNCTION ) DATA - - -)
      READ(5,1000) (PY(I),I=1,NB)
 1000 FORMAT(16F5.2)
      READ(5,1000) (BMYY(I),I=1,NB)
```

```
      READ(5,1000) (BMZY(I),I=1,NB)
      READ(5,1001) FACT,NSTART,ISYM
 1001 FORMAT(D10.5,2I5)
      WRITE(6,2001) FACT,NSTART,ISYM
 2001 FORMAT(1H0,19H FACT,NSTART,ISYM =,D10.5,2I5)
      WRITE(6,2002)
 2002 FORMAT(1H0,4X,5HLEVEL,8X,6HZ0(CM),7X,10HYIELD LOAD,4X,
     113HLAT YIELD MOM,2X,14HA-P YIELD MOM ,/)
      DO 10 I=1,NB
      PY(I)=PY(I)*FACT
      BMYY(I)=BMYY(I)*FACT*2.0
      BMZY(I)=BMZY(I)*FACT*2.0
      Z(I)=ZC(INMESH(NSTART+I-1))
   10 WRITE(6,2003) I,Z(I),PY(I),BMYY(I),BMZY(I)
 2003 FORMAT(1H ,5X,I2,3X,4D15.4)
C
      DO 20 I=1,NB
      PSUM(I)=0.D0
      VYSUM(I)=0.D0
      VZSUM(I)=0.D0
      TSUM(I)=0.D0
      BMYSUM(I)=0.D0
      BMZSUM(I)=0.D0
      P(I)=0.D0
      VY(I)=0.D0
      VZ(I)=0.D0
      T(I)=0.D0
      BMY(I)=0.D0
      BMZ(I)=0.D0
      F1(I)=0.D0
      F2(I)=0.D0
   20 F(I)=0.D0
      FREQ=FLOAT(NPFREQ)
      PER=FREQ*DELT
   30 CONTINUE
      IF(JE.GT.JSTART) GO TO 40
      JV=0
C
C     LOADS ON INFERIOR ENDPLATE OF FIRST VERTEBRA CONSIDERED -
C     TYPICALLY L5 ( HUMAN ), L6 OR L7 ( BABOON )
C
C     SIGN CONVENTIONS
C
C     PI   = AXIAL FORCE - LT/GT 0 - C/T
C     VYI  = LOCAL Y SHEAR - LT/GT 0 - FLEX/EXT
C     VZI  = LOCAL Z SHEAR - LT/GT 0 - RIGHT/LEFT LAT BENDING
C     TI   = TORSION - LT/GT 0 - NEG/POS ROT ABOUT ANATOMICAL Z
C     BMYI = LOCAL Y MOMENT - LT/GT 0 - RIGHT/LEFT LAT BENDING
C     BMZI = LOCAL Z MOMENT - LT/GT 0 - FLEX/EXT
C
      PI=FORCE(2)
      VYI=FORCE(4)
      IF(ISYM.EQ.0) GO TO 35
      VZI=-FORCE(6)
      TI=BMOMT(2)
      BMYI=BMOMT(4)
   35 BMZI=BMOMT(6)
      GO TO 999
   40 JV=JV+1
      IF(JE.EQ.JEND) GO TO 56
C
C     LOADS ON SUPERIOR ENDPLATES
C
C     SIGN CONVENTIONS FOR PS,VYS,VZS,TS,BMYS AND BMZS SIMILAR TO
C     THOSE FOR INFERIOR ENDPLATE LOADS
C
      PS=-FORCE(1)
      VYS=FORCE(3)
      IF(ISYM.EQ.0) GO TO 45
      VZS=-FORCE(5)
      TS=BMOMT(1)
      BMYS=-BMOMT(3)
   45 BMZS=-BMOMT(5)
C
C     DETERMINE EQUILIBRIUM VALUES OF INTERNAL LOADS
C     EG. P ( EQUILIBRIUM ) = 0.5 * ( PI + PS )
```

```
C
      PE(JV)=0.5D0*(PI+PS)
C     WRITE(6,4105)
      IF(PE(JV).GT.0.D0) PE(JV)=0.D0
C     WRITE(6,4105)
      VYE(JV)=0.5D0*(VYI+VYS)
C     WRITE(6,4105)
      IF(ISYM.EQ.0) GO TO 50
      VZE(JV)=0.5D0*(VZI+VZS)
      TE(JV)=0.5D0*(TI+TS)
      BMYE(JV)=0.5D0*(BMYI+BMYS)
   50 BMZE(JV)=0.5D0*(BMZI+BMZS)
C
C     LOADS ON REMAINING INFERIOR ENDPLATES
C
      PI=FORCE(2)
      VYI=FORCE(4)
      IF(ISYM.EQ.0) GO TO 55
      VZI=-FORCE(6)
      TI=BMOMT(2)
      BMYI=BMOMT(4)
   55 BMZI=BMOMT(6)
      GO TO 999
   56 PE(JV)=PI
      IF(PE(JV).GT.0.D0) PE(JV)=0.D0
      VYE(JV)=VYI
      IF(ISYM.EQ.0) GO TO 57
      VZE(JV)=VZI
      TE(JV)=TI
      BMYE(JV)=BMYI
   57 BMZE(JV)=BMZI
C
C     SUM LOADS
C
   60 DO 70 I=1,NB
      PSUM(I)=PSUM(I)+PE(I)
      VYSUM(I)=VYSUM(I)+VYE(I)
      IF(ISYM.EQ.0) GO TO 70
      VZSUM(I)=VZSUM(I)+VZE(I)
      TSUM(I)=TSUM(I)+TE(I)
      BMYSUM(I)=BMYSUM(I)+BMYE(I)
   70 BMZSUM(I)=BMZSUM(I)+BMZE(I)
C
C     IF CURRENT TIME STEP IS NOT AN ENDPOINT OF A SAMPLING INTERVAL,
C     RETURN
C
      IF(NTSTEP.NE.N2) GO TO 999
      TYME=0.5D0*(2.D0*DFLOAT(N1)-1.D0)*PER
C
      DO 80 I=1,NB
      PE(I)=PSUM(I)/FREQ
      VYE(I)=VYSUM(I)/FREQ
      VYEA(I)=DABS(VYE(I))                          RVCC
      IF(ISYM.EQ.0) GO TO 71
      VZE(I)=VZSUM(I)/FREQ
      VZEA(I)=DABS(VZE(I))                          RVCC
      TE(I)=TSUM(I)/FREQ
      TEA(I)=DABS(TE(I))                            RVCC
      BMYE(I)=BMYSUM(I)/FREQ
      BMYEA(I)=DABS(BMYE(I))                        RVCC
   71 BMZE(I)=BMZSUM(I)/FREQ
      BMZEA(I)=DABS(BMZE(I))                        RVCC
      IF(PE(I).GT.P(I)) GO TO 72
      P(I)=PE(I)
      TP(I)=TYME
   72 IF(DABS(VYE(I)).LT.DABS(VY(I))) GO TO 73
      VY(I)=VYE(I)
      TVY(I)=TYME
   73 IF(ISYM.EQ.0) GO TO 77
      IF(DABS(VZE(I)).LT.DABS(VZ(I))) GO TO 74
      VZ(I)=VZE(I)
      TVZ(I)=TYME
   74 IF(DABS(TE(I)).LT.DABS(T(I))) GO TO 75
      T(I)=TE(I)
      TT(I)=TYME
   75 IF(DABS(BMYE(I)).LT.DABS(BMY(I))) GO TO 76
```

```
      BMY(I)=BMYE(I)
      TMY(I)=TYME
   76 VZSUM(I)=0.D0
      TSUM(I)=0.D0
      BMYSUM(I)=0.D0
   77 IF(DABS(BMZE(I)).LT.DABS(BMZ(I))) GO TO 78
      BMZ(I)=BMZE(I)
      TMZ(I)=TYME
   78 PSUM(I)=0.D0
      VYSUM(I)=0.D0
      BMZSUM(I)=0.D0
   80 CONTINUE
      N1=N1+1
C
C   UPDATE SPINAL INJURY FUNCTION
C
      DO 90 I=1,NB
      FP=DABS(PE(I))/PY(I)
      FMZ=DABS(BMZE(I))/BMZY(I)
      FTEMP=FP+FMZ
      IF(FTEMP.LT.F1(I)) GO TO 81
      F1(I)=FTEMP
      FA(I)=F1(I)
      PF1(I)=PE(I)
      BMF1(I)=BMZE(I)
      TF1(I)=TYME
   81 FMY=0.D0
      IF(ISYM.EQ.0) GO TO 90
      FMY=DABS(BMYE(I))/BMYY(I)
      FTEMP=FP+FMY
      IF(FTEMP.LT.F2(I)) GO TO 82
      F2(I)=FTEMP
      PF2(I)=PE(I)
      BMF2(I)=BMYE(I)
      TF2(I)=TYME
   82 FTEMP=FP+DMAX1(FMY,FMZ)
      IF(FTEMP.LT.F(I)) GO TO 90
      F(I)=FTEMP
      FA(I)=F(I)
      PF(I)=PE(I)
      BMF(I)=BMYE(I)
      IF(FMZ.GE.FMY) BMF(I)=BMZE(I)
      TF(I)=TYME
   90 CONTINUE
C                                                  RVCC
C IF COLOR CODING IS DESIRED, WRITE RV DATA TO LU 11.          RVCC
      IF(KONTRL(12).EQ.1) THEN                     RVCC
        WRITE(11,5000) (PE(I),I=1,9)               RVCC
        WRITE(11,5001) (PE(I),I=10,17)             RVCC
        WRITE(11,5000) (TEA(I),I=1,9)              RVCC
        WRITE(11,5001) (TEA(I),I=10,17)            RVCC
        WRITE(11,5000) (BMYEA(I),I=1,9)            RVCC
        WRITE(11,5001) (BMYEA(I),I=10,17)          RVCC
        WRITE(11,5000) (BMZEA(I),I=1,9)            RVCC
        WRITE(11,5001) (BMZEA(I),I=10,17)          RVCC
        WRITE(11,5000) (VZEA(I),I=1,9)             RVCC
        WRITE(11,5000) (VZEA(I),I=10,17)           RVCC
        WRITE(11,5000) (VYEA(I),I=1,9)             RVCC
        WRITE(11,5001) (VYEA(I),I=10,17)           RVCC
        WRITE(11,5000) (FA(I),I=1,9)               RVCC
        WRITE(11,5001) (FA(I),I=10,17)             RVCC
5000    FORMAT(9D14.7)                             RVCC
5001    FORMAT(8D14.7)                             RVCC
      END IF                                       RVCC
C                                                  RVCC
      IF(NTSTEP.LT.MXSTEP) GO TO 999
C
C   OUTPUT
C
      WRITE(6,3000)
 3000 FORMAT(1H1,75H * * * * * * * SPINAL INJURY LIKELIHOOD POSTPROCESSI
     1NG OUTPUT * * * * * * *)
      WRITE(6,3001)
 3001 FORMAT(1H-,71H - - - - - - - MAX COMPRESSIVE FORCES AND BENDING MO
     1MENTS - - - - - - -//
     228H P  = MAX COMPRESSIVE FORCE//
```

```
    356H BMY = MAX LAT MOMENT - LT/GT 0 - RIGHT/LEFT LAT BENDING//
    442H BMZ = MAX A-P MOMENT - LT/GT 0 - FLEX/EXT//
    548H TP,TMY,TMZ = TIMES AT WHICH P,BMY AND BMZ OCCUR//
    628H PY,BMYY,BMZY = YIELD VALUES)
     WRITE(6,3002)
 3002 FORMAT(1H-,3X,5HLEVEL,6X,2HTP,10X,1HP,12X,2HPY,9X,3HTMY,
    18X,3HBMY,10X,4HBMYY,8X,3HTMZ,8X,3HBMZ,10X,4HBMZY/)
     DO 100 I=1,NB
  100 WRITE(6,3003) I,TP(I),P(I),PY(I),TMY(I),BMY(I),BMYY(I),
    1TMZ(I),BMZ(I),BMZY(I)
 3003 FORMAT(1H ,1X,I5,4X,3(F10.6,1PD13.4,1PD13.4))
     DO 110 I=1,NB
  110 TEMP(I)=P(I)/PY(I)
     CALL PLOTER(NB,Z,TEMP,PLOT1,ZLABEL,-1,0)
     DO 120 I=1,NB
  120 TEMP(I)=BMZ(I)/BMZY(I)
     CALL PLOTER(NB,Z,TEMP,PLOT3,ZLABEL,-1,0)
     IF(ISYM.EQ.0) GO TO 150
     DO 130 I=1,NB
  130 TEMP(I)=BMY(I)/BMYY(I)
     CALL PLOTER(NB,Z,TEMP,PLOT2,ZLABEL,-1,0)
C
     WRITE(6,3004)
 3004 FORMAT(1H1,51H - - - - - - - MAX SHEARS AND T0RSION - - - - - - -,
    1//
    239H VY = MAX Y SHEAR - LT/GT 0 - A/P SHEAR//
    348H VZ = MAX LAT SHEAR - LT/GT 0 - RIGHT/LEFT SHEAR//
    443H T  = MAX TORSION - LT/GT 0 - -/+ Z BAR ROT//
    546H TVY,TVZ,TT = TIMES AT WHICH VY,VZ AND T OCCUR)
     WRITE(6,3005)
 3005 FORMAT(1H-,3X,5HLEVEL,6X,3HTVY,9X,2HVY,9X,3HTVZ,9X,2HVZ,9X,
    12HTT,10X,1HT/)
     DO 140 I=1,NB
  140 WRITE(6,3006) I,TVY(I),VY(I),TVZ(I),VZ(I),TT(I),T(I)
 3006 FORMAT(1H ,1X,I5,4X,3(F10.6,1PD13.4))
     CALL PLOTER(NB,Z,VY,PLOT4,ZLABEL,-1,0)
     CALL PLOTER(NB,Z,VZ,PLOT5,ZLABEL,-1,0)
     CALL PLOTER(NB,Z,T,PLOT6,ZLABEL,-1,0)
C
  150 WRITE(6,3007)
 3007 FORMAT(1H1,63H * * * * * * * " SAGITTAL PLANE " INJURY FUNCTION *
    1* * * * * *//
    233H F1 = ( ABS(P/PY) + ABS(MZ/MZY) )//
    344H TF1 = TIMES AT WHICH F1, PF1 AND BMF1 OCCUR)
     WRITE(6,3008)
 3008 FORMAT(1H-,3X,5HLEVEL,6X,3HTF1,9X,2HF1,10X,3HPF1,11X,2HPY,
    110X,4HBMF1,9X,4HBMZY/)
     DO 160 I=1,NB
  160 WRITE(6,3009) I,TF1(I),F1(I),PF1(I),PY(I),BMF1(I),BMZY(I)
 3009 FORMAT(1H ,1X,I5,4X,F10.6,5(1PD13.4))
     CALL PLOTER(NB,Z,F1,PLOT7,ZLABEL,-1,0)
     IF(ISYM.EQ.0) GO TO 999
C
     WRITE(6,3010)
 3010 FORMAT(1H1,62H - - - - - - - " FRONTAL PLANE " INJURY FUNCTION - -
    1 - - - - -,//
    233H F2 = ( ABS(P/PY) + ABS(MY/MYY) )//
    344H TF2 = TIMES AT WHICH F2, PF2 AND BMF2 OCCUR)
     WRITE(6,3011)
 3011 FORMAT(1H-,3X,5HLEVEL,6X,3HTF2,9X,2HF2,10X,3HPF2,11X,2HPY,10X,
    14HBMF2,9X,4HBMYY/)
     DO 170 I=1,NB
  170 WRITE(6,3012) I,TF2(I),F2(I),PF2(I),PY(I),BMF2(I),BMYY(I)
 3012 FORMAT(1H ,1X,I5,4X,F10.6,5(1PD13.4))
     CALL PLOTER(NB,Z,F2,PLOT8,ZLABEL,-1,0)
C
     WRITE(6,3013)
 3013 FORMAT(1H1,88H * * * * * * * COMBINED " SAGITTAL " AND " FRONTAL  "
    1 PLANE INJURY FUNCTION * * * * * * *,//
    253H F = ( ABS(P/PY) + MAX( ABS(MY/MYY) , ABS(MZ/MZY) ) )//
    340H TF = TIMES AT WHICH F, PF AND BMF OCCUR)
     WRITE(6,3014)
 3014 FORMAT(1H-,3X,5HLEVEL,6X,2HTF,10X,1HF,12X,2HPF,11X,2HPY,10X,3HBMF,
    110X,4HBMYY,9X,4HBMZY)
     DO 180 I=1,NB
  180 WRITE(6,3015) I,TF(I),F(I),PF(I),PY(I),BMF(I),BMYY(I),BMZY(I)
```

```
3015 FORMAT(1H ,1X,I5,4X,F10.6,6(1PD13.4))
   CALL PLOTER(NB,Z,F,PLOT9,ZLABEL,-1,0)
C
 999 RETURN
   END
```

```
      SUBROUTINE SUBTIM(HL,HS,ML,MS,SL,SS,CL,CS,DH,DM,DS,DC)
C
C   SUBROUTINE TO SUBTRACT A SMALLER TIME FROM A LARGER TIME
C
      INTEGER*2 HL,HS,SHL,SHS,ML,MS,SML,SMS,SL,SS,SSL,SSS,
     &         CL,CS,SCL,SCS,DH,DM,DS,DC
C
C  PRESERVE THE CALLING VARIABLES
C
      SHL = HL
      SHS = HS
      SML = ML
      SMS = MS
      SSL = SL
      SSS = SS
      SCL = CL
      SCS = CS
C
C  DO ALL ARITHMETIC WITH SAVED VARIABLES
C
      IF(SCL .LT. SCS) THEN
        DC = SCL + 100 - SCS
        SSL = SSL - 1
       ELSE
        DC = SCL - SCS
      END IF
      IF(SSL .LT. SSS) THEN
        DS = SSL + 60 - SSS
        SML = SML - 1
       ELSE
        DS = SSL - SSS
      END IF
      IF(SML .LT. SMS) THEN
        DM = SML + 60 - SMS
        SHL = SHL - 1
       ELSE
        DM = SML - SMS
      END IF
      DH = SHL - SHS
      RETURN
      END
```

```
      SUBROUTINE UPDATE (NPRI,NDGREE,DELT,X1,XO,V,A,BLAMB,BETA)
C
Cbrc
Cbrc  CLEANED UP SOME CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
      INCLUDE 'ADJUST.COM'
      COMMON /DYNAM/ NDUM(3), NTSTEP, TIME
      DOUBLE PRECISION E1,E3,E31S,E32S
C
      DIMENSION V(NVO), A(NA1), BLAMB(NNBLAM), E1(3), E3(3), TEMP1(3),
     1        TEMP2(3), X1(NX1), XO(NXO)
C
C.... THIS SUBROUTINE UPDATES THE BODY COORDINATES  LAMBDA - BAR
C
      NEQ=NPRI*NDGREE
      IMPUPD=0
      IF (BETA.NE.0.) IMPUPD=1
C
      J1=4
      K1=1
      J=J1
      K=K1
      DELT2=DELT/2.D0
      DELTT2=DELT*DELT2
    1 J2=J+1
      J3=J+2
      K2=K+1
      K3=K+2
      K4=K+3
      K5=K+4
      K6=K+5
      K7=K+6
      K8=K+7
      K9=K+8
C
C.... FIND  E3X, E3Y, AND E1Y
C
      IF (IMPUPD.EQ.0) GO TO 2
C
      DTHETX=X1(J1)-XO(J1)
      DTHETY=X1(J2)-XO(J2)
      DTHETZ=X1(J3)-XO(J3)
      OMEGAX=V(J1)*DELT2
      OMEGAZ=V(J3)*DELT2
      CONX=1.D0+OMEGAX*OMEGAX
      CONZ=1.D0+OMEGAZ*OMEGAZ
C
      E3(1)=(OMEGAZ*DTHETX+DTHETY)/CONZ
      E3(2)=(OMEGAZ*DTHETY-DTHETX)/CONZ
      E1(2)=(OMEGAX*DTHETY+DTHETZ)/CONX
C
      GO TO 3
    2 E3(1)=DELT*V(J2)+DELTT2*(V(J1)*V(J3)+A(J2))
      E3(2)=-DELT*V(J1)+DELTT2*(V(J2)*V(J3)-A(J1))
      E1(2)=DELT*V(J3)+DELTT2*(V(J1)*V(J2)+A(J3))
    3 IF (DABS(E3(1)).LT.1.0D-20) E3(1)=0.D0
      IF (DABS(E3(2)).LT.1.0D-20) E3(2)=0.D0
      IF (DABS(E1(2)).LT.1.0D-20) E1(2)=0.D0
C
C....  FIND E3Z AND NORMALIZE E3
C
      E31S=E3(1)*E3(1)
      E32S=E3(2)*E3(2)
      E3(3)=-.5D0*(E31S+E32S)
C     ALSQR = E31S + E32S + ( 1.D0+E3(3) )*( 1.D0+E3(3) )
C     IF ( ALSQR .LT. 0.0 )  GO TO 10
   13 CONTINUE
      AL=DSQRT(E31S+E32S+(1.D0+E3(3))*(1.D0+E3(3)))
      E3(1)=E3(1)/AL
      E3(2)=E3(2)/AL
      E3(3)=(1.D0+E3(3))/AL
C
C....   COMPLETE E1
C
```

```
      E1(3)=-(E3(1)+E1(2)*E3(2))/E3(3)
C     E11SQR = 1.D0 - E1(2)*E1(2) - E1(3)*E1(3)
C     IF ( E11SQR .LT. 0.0 )  GO TO 11
   14 CONTINUE
      E1(1)=DSQRT(1.D0-E1(2)*E1(2)-E1(3)*E1(3))
C
C....  TRANSFORM TO NEW SYSTEM AND STORE IN OLD VECTOR POSITIONS)
C
      TEMP1(1)=BLAMB(K1)*E3(1)+BLAMB(K4)*E3(2)+BLAMB(K7)*E3(3)
      TEMP1(2)=BLAMB(K2)*E3(1)+BLAMB(K5)*E3(2)+BLAMB(K8)*E3(3)
      TEMP1(3)=BLAMB(K3)*E3(1)+BLAMB(K6)*E3(2)+BLAMB(K9)*E3(3)
      TEMP2(1)=BLAMB(K1)*E1(1)+BLAMB(K4)*E1(2)+BLAMB(K7)*E1(3)
      TEMP2(2)=BLAMB(K2)*E1(1)+BLAMB(K5)*E1(2)+BLAMB(K8)*E1(3)
      TEMP2(3)=BLAMB(K3)*E1(1)+BLAMB(K6)*E1(2)+BLAMB(K9)*E1(3)
      BLAMB(K1)=TEMP2(1)
      BLAMB(K2)=TEMP2(2)
      BLAMB(K3)=TEMP2(3)
      BLAMB(K4)=TEMP1(2)*TEMP2(3)-TEMP1(3)*TEMP2(2)
      BLAMB(K5)=TEMP1(3)*TEMP2(1)-TEMP1(1)*TEMP2(3)
      BLAMB(K6)=TEMP1(1)*TEMP2(2)-TEMP1(2)*TEMP2(1)
      BLAMB(K7)=TEMP1(1)
      BLAMB(K8)=TEMP1(2)
      BLAMB(K9)=TEMP1(3)
      J1=J1+6
      K1=K1+9
      J=J1
      K=K1
      IF (J1.LT.NEQ) GO TO 1
      RETURN

      END
```

```
      SUBROUTINE VECT (X,Y,Z,A,B,C,ABC,D1,BETA,XC,YC,ZC)
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... THIS ROUTINE CALCULATES THE COMPONENTS OF ELEMENT
C.... UNIT VECTORS E-1  AND  E-2
C
      DIMENSION X(2), Y(2), Z(2)
C
      CB=DCOS(BETA)
      SB=DSIN(BETA)
      XC=((X(2)-X(1))*CB+(B*(Z(2)-Z(1))-C*(Y(2)-Y(1)))*SB/ABC)/D1
      YC=((Y(2)-Y(1))*CB+(C*(X(2)-X(1))-A*(Z(2)-Z(1)))*SB/ABC)/D1
      ZC=((Z(2)-Z(1))*CB+(A*(Y(2)-Y(1))-B*(X(2)-X(1)))*SB/ABC)/D1
      RETURN
      END
```

```
      SUBROUTINE VECTOR (X,Y,Z,SIDE,S,A,B,C,ABC)
C
Cbrc
Cbrc  CLEANED UP CODE - DJP
Cbrc
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
C.... THIS ROUTINE CALCULATES TRIANGULAR ELEMENT SIDE
C.... LENGTHS AND UNIT NORMAL PARAMETERS
C
      INCLUDE 'ADJUST.COM'
      DIMENSION X(3), Y(3), Z(3), SIDE(3)
C
      S=0.D0

      DO I=1,3
       J=I+1
       IF (I.EQ.3) J=1
       SIDE(I)=DSQRT((X(J)-X(I))**2+(Y(J)-Y(I))**2+(Z(J)-Z(I))**2)
       S=S+SIDE(I)
      END DO

      S=.5D0*S
      A=Y(1)*(Z(2)-Z(3))+Y(2)*(Z(3)-Z(1))+Y(3)*(Z(1)-Z(2))
      B=X(1)*(Z(3)-Z(2))+X(2)*(Z(1)-Z(3))+X(3)*(Z(2)-Z(1))
      C=X(1)*(Y(2)-Y(3))+X(2)*(Y(3)-Y(1))+X(3)*(Y(1)-Y(2))
      ABC=DSQRT(A*A+B*B+C*C)

      RETURN
      END
```

```
      PROGRAM WHAM3
C
C.... ******************************************************************
C.... ******************************************************************
C.... ******************************************************************
C....                                          ****
C....  S T R U C T U R E   O F  Q   A R R A Y          ****
C....                                          ****
C....  NAME     SIZE          DESCRIPTION             ****
C....                                          ****
C....  FINT    2*NDGREE*NPRI     INTERNAL FORCE ARRAY        ****
C....  XC      NODET          X COORDINATE OF NODE POINTS ****
C....  YC      NODET          Y COORDINATE OF NODE POINTS ****
C....  ZC      NODET          Z COORDINATE OF NODE POINTS ****
C....  INMESH  NODMAX           INTERNAL NODE NUMBER LOCATOR ****
C....  MESHIN  NODET            MESH NODE NUMBER LOCATOR   ****
C....  LX0     MEQ           OLD NODAL DISPLACEMENT ARRAY ****
C....  LX1     MEQ           NEW NODAL DISPLACEMENT ARRAY ****
C....  BLAMB   9*NPRI          NODAL BODY VECTOR ARRAY     ****
C....  V0      N1           OLD NODAL VELOCITY ARRAY   ****
C....  A0      N1           OLD NODE ACCL. ARRAY      ****
C....  A1      N1           NEW NODE ACCL. ARRAY      ****
C....  SMASS   N1            NODAL MASS ARRAY         ****
C....  FORCD   N1            NEW EXTERNAL FORCE ARRAY    ****
C....  FEXOLD  N1            OLD EXTERNAL FORCE ARRAY    ****
C....  AUX     N1           DEFORMED CORRDINATE ARRAY   ****
C....  INDEX   NELE+1          INDEX TO SRRS ARRAY       ****
C....  IX      NELE*7        ELEMENT ARRAY          ****
C....  AL      NELE          ORIGINAL ELEMENT LENGTHS
C....  DICOS   NELE*9          DIRECTION COSIN ARRAY      ****
C....  E       NUMMAT*12        MATERIAL PROPERTIES ARRAY   ****
C....  NODDIS  NUMDIS+1         FIXITIES ARRAY         ****
C....  IPT     NUMSEC         NO. OF INTEGRATION PTS PER SECTIO
C....  STRS                STRESS ARRAY          ****
C....  STRESS  2*MAXIPT         STRESS AT INTEGRATION PTS
C....  STRAIN  2*MAXIPT         STRAIN AT INTEGRATION PTS
C....  YIPT    MAXIPT         Y COORDINATES OF INTEGRATION
C....  ZIPT    MAXIPT         Z COORDINATES OF INTEGRATION
C....  XLEN    MAXIPT          LENGTHS FOR INTEGRATION
C....  THCK    NUMSEC          THICKNESS FOR INTEGRATION
C....  T       NPTS          TIME ARRAY FOR OUTPUT      ****
C....  UOUT    NPRU           NODAL OUTPUT ARRAY        ****
C....  SOUT    NPRS           ELEMENT OUTPUT CODE ARRAY  ****
C....  NPOUT   NPIC           PICTURE OUTPUT ARRAY       ****
C....  GLABEL  20*NPLOT         PLOTER OUTPUT LABELS      ****
C....  PSU     NPTS*NPLOT        OUTPUT PTS. FOR TIME HISTORY ****
C....  UU      NPRU          OUTPUT KINEMATIC VALUES    ****
C....  SS      NPRS          OUTPUT FORCE   VALUES    ****
C....  A       NPTS          OUTPUT DEPENDENT VARIABLE  ****
C....  NTYPE   NPLOT          PLOT TYPE IDENTIFIER      ****
C....                                          ****
C....  FOR SLIDING INTERFACES ONLY
C....                                          ****
C....  NCP     10*NOPT         NUMBER OF CONTACT POINTS    ****
C....  NASN    3*NOPT          NODE NUMBERS OF CONTACT POINT****
C....  DICOSP  3*NOPT          DIRECTION OF MOTION OF PLANE
C....  ALPHA   9*NOPT          UNIT NORMAL TO SLIDING PLANE ****
C....  UP      3*NOPT         DISPLACEMENT OF PLANE      ****
C....  UP2     3*NOPT         ACCELERATION OF PLANE      ****
C....  NPNO    NOPT          NODE NO. OF PLANES
C....  SEATK   2*NOPT          STIFFNESS FOR PLANES
C....  UPOLD   3*NOPT          OLD DISP OF PLANES
C....  VDAMP   NOPT           DAMPING COEFFICIENTS FOR PLANES
C....  UP1     3*NOPT         VELOCITIES OF PLANES
C....                                          ****
C.... ******************************************************************
C.... ******************************************************************
C.... ******************************************************************
C
      IMPLICIT DOUBLE PRECISION (A-H,O-Z)
C
Cbrc
Cbrc COMMON INCLUDES ADDED TO ELIMINATE SOME MESSINESS - DJP
Cbrc
      INCLUDE 'ADJUST.COM'
      INCLUDE 'ARRAY.COM'
```

```
      INCLUDE 'CONTRL.COM'
      INCLUDE 'DYNAM.COM'
      INCLUDE 'INDEX.COM'
      INCLUDE 'OUTPA.COM'
      INCLUDE 'SIZE.COM'
      INCLUDE 'NUMINT.COM'
      INCLUDE 'PRESBC.COM'
      COMMON /DEVS/ LUTRM, LUIN, LUOUTP, LUPLT
      COMMON /LABELS/ NAINP,NAOUT,NAPLT
      INTEGER INP, OUT, PLT , LUTRM, LUIN, LUOUTP, LUPLT
      CHARACTER*64 NAINP,NAOUT,NAPLT
      INTEGER*2 HR, MIN, SEC, CENTS, DHR, DMIN, DSEC, DCENTS, DH, DM,
     &        DS,DC
      CHARACTER*8 SRNAME
      DIMENSION IQ(1)
      DIMENSION XO(2000),X1(2000)
C     DIMENSION IQT(200)
      DOUBLE PRECISION DQ(1)
      EQUIVALENCE (Q(1),DQ(1),IQ(1))
      EQUIVALENCE (Q(1199),XO(1))
      EQUIVALENCE (Q(2765),X1(1))
C     EQUIVALENCE (Q(12781),IQT(1))
      DIMENSION TITLE(20)
      DATA REST1,REST2 /4HREST,4HART /
C
Cbrc
Cbrc  GO TO'S REPLACED WITH DO..END DO AND IF..END IF
Cbrc
      MAXQ = 45000
      DO LEN=1,MAXQ
       Q(LEN)=0.D0
      END DO
Cbrc
Cbrc   OPEN I/0 DEVICES BY CALLING IODECLS - JBB
Cbrc
      INP = 1
      OUT = 1
      PLT = 1
      CALL IODECLS(INP, OUT, PLT)
C
C.... READ TITLE ****
C
      READ(5,901) TITLE
      WRITE (6,902) TITLE
      WRITE(LUOUTP,'(//,5X,"****TIME SET TO ZERO AFTER I/O DEFS",//)')
      IF(TITLE(1) .EQ. REST1 .OR. TITLE(2) .EQ. REST2) STOP
C
C.... READ IN SIZE OF PROBLEM ****
C
      READ(5,903) NNODE,NPRI,NAXOR,NELE,NUMMAT,NUMDIS,MXSTEP,NDGREE,
     1         DELT,NODMAX
C
C.... NET UP INDEX TO Q ARRAY ****
C
      MEQ=NNODE*NDGREE
      NODET=NNODE+NAXOR
      IF (NODMAX.EQ.0) NODMAX=NODET
      N1=NPRI*NDGREE
      LFINT=1
      LXC=NPRI*NDGREE+LFINT
      LYC=NODET+LXC
      LZC=NODET+LYC
      LINMEH=NODET+LZC
      NADD = 0
      IF ( MOD(NODMAX,2) .NE. 0 )  NADD = 1
      LMESHN = NODMAX/2 + NADD + LINMEH
      NADD = 0
      IF ( MOD(NODET,2) .NE. 0 )  NADD = 1
      LXO = NODET/2 + NADD + LMESHN
      LX1=MEQ+LXO
      LBLAMB=MEQ+LX1
      LVO=NPRI*9+LBLAMB
      LAO=N1+LVO
      LA1=N1+LAO
      LSMASS=N1+LA1
      LFORCD=N1+LSMASS
```

```
      LFEXOD=N1+LFORCD
      LAUX=N1+LFEXOD
      LINDEX=MEQ+LAUX
      IXADD = 0
      IF ( MOD(NELE,2) .NE. 0 )  IXADD = 1
      LIX = NELE/2 + 1 + IXADD + LINDEX
      LAL = NELE*7 + LIX
      LDICOS=NELE+LAL
      LE=NELE*9+LDICOS
      LNODIS=NUMMAT*12+LE
      LANGLE=NUMDIS/2+LNODIS+2
      LIPT=9*NUMDIS+LANGLE
      WRITE (6,904) LIPT
C
      NFINT = NPRI*NDGREE
      NXC = NODET
      NYC = NODET
      NZC = NODET
      NINMEH = NODMAX
      NMESHN = NODET
      NXO = MEQ
      NX1 = MEQ
      NBLAMB = NPRI
      NNBLAM = 9*NPRI
      NVO = N1
      NAO = N1
      NA1 = N1
      NSMASS = N1
      NFORCD = N1
      NFEXOD = N1
      NAUX = MEQ
      NINDEX = NELE+1
      NIX = NELE
      NAL = NELE
      NDICOS = NELE
      NE = NUMMAT
      NNODIS = NUMDIS+1
      NANGLE = NUMDIS
C
C.... CALL READIN ****
C
      CALL GETTIM(HR,MIN,SEC,CENTS)
      SRNAME = '  READIN'
      CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
      CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
      WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUTRM,920) SRNAME, DH, DM, DS, DC
      WRITE(LUOUTP,920) SRNAME, DH, DM, DS, DC
      CALL READIN (Q(LSMASS),Q(LE),Q(LXC),Q(LYC),Q(LZC),Q(LIX),Q(LXO),
     1         Q(LX1),Q(LDICOS),Q(LMESHN),Q(LINMEH),Q(LNODIS),
     2         Q(LANGLE))
      CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
      CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
      WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUTRM,921) SRNAME, DH, DM, DS, DC
      WRITE(LUOUTP,921) SRNAME, DH, DM, DS, DC
C
      IF ( KONTRL(12) .NE. 0 ) THEN
       MEQ2 = NNODE-NPRI
       LXT = LIPT+1
       LYT = MEQ2+LXT
       LZT = MEQ2+LYT
       LIPT = MEQ2+LZT
       NXT = MEQ2
       NYT = MEQ2
       NZT = MEQ2
       NIPT = 3*MEQ
       NNODE1 = NNODE-1
       DO I=NPRI,NNODE1
        Q( LXT-NPRI+I ) = Q( LXO+I )
        Q( LYT-NPRI+I ) = Q( LX1+I )
        Q( LZT-NPRI+I ) = Q( LDICOS+I )
       END DO
      END IF
```

```
      NUMSEC=0
      LSTRS=LIPT+1
      NSTRS = 0
      IF(KONTRL(9).NE.0) THEN
C
C.... READ NUMBER OF CROSS SECTIONAL GEOMETRIES
C
       READ (5,905) NUMSEC, MAXIPT
       LSTRS=LIPT+NUMSEC/2 + 1
       NSTRS = NUMSEC
C
      END IF
C
C.... ASSEMBLE ELEMENT INFORMATION
C
      NSTRS = NSTRS + NUMMAT + MAXQ/2
C
      SRNAME = '  ASSBLE'
      CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
      CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
      WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUTRM,920) SRNAME, DH, DM, DS, DC
      WRITE(LUOUTP,920) SRNAME, DH, DM, DS, DC
      CALL ASSBLE (Q(LIX),Q(LXC),Q(LYC),Q(LZC),Q(LE),Q(LSMASS),Q(LBLAMB)
     1          ,Q(LDICOS),Q(LINDEX),Q(LSTRS),Q(LIPT),Q(LAL))
      CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
      CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
      WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
      WRITE(LUTRM,921) SRNAME, DH, DM, DS, DC
      WRITE(LUOUTP,921) SRNAME, DH, DM, DS, DC
      LSTRES=IQ(2*LINDEX-1+NELE)+1+NUMMAT+LSTRS
      WRITE (6,908)  LSTRES
C
      LSTRAI=LSTRES+2*MAXIPT
      LYIPT=LSTRAI+2*MAXIPT
      LZIPT=LYIPT+MAXIPT*NUMSEC
      LXLEN=LZIPT+MAXIPT*NUMSEC
      LTHCK=LXLEN+MAXIPT*NUMSEC
      LFTIME=LTHCK+2*NUMSEC
      NSTRS = LSTRES - LSTRS
      NSTRES = MAXIPT * 2
      NSTRAI = MAXIPT * 2
      NYIPT = NUMSEC
      NZIPT = NUMSEC
      NXLEN = NUMSEC
      NTHCK = NUMSEC*2
C
C.... READ PRESCRIBED BOUNDARY CONDITION DATA AND ALLOCATE SPACE
C
      READ (5,903) NFLC,MFPTS,NFNODE,NDLC,MDPTS,NDNODE,IVNODE
C
      LFFCN=LFTIME+MFPTS*NFLC
      LDTIME=LFFCN+MFPTS*NFLC
      LDFCN=LDTIME+MDPTS*NDLC
      LNODEF=LDFCN+MDPTS*NDLC
      LIDIR=LNODEF+(NFNODE+NDNODE)/2 + 1
      LNCURV=LIDIR+(NFNODE+NDNODE)/2 + 1
      LCOEF=LNCURV+(NFNODE+NDNODE)/2 + 1
      LT=LCOEF+NFNODE+NDNODE
      NFTIME = NFLC
      NFFCN = NFLC
      NDTIME = NDLC
      NDFCN = NDLC
      NNODEF = NFNODE+NDNODE
      NIDIR = NFNODE+NDNODE
      NNCURV = NFNODE+NDNODE
      NCOEF = NFNODE+NDNODE
C
C.... READ FORCE AND DISPLACEMENT DATA
C
Cbrc  DOES READFD MATTER?
Cbrc    CALL READFD (Q(LFTIME),Q(LFFCN),Q(LDTIME),Q(LDFCN),Q(LNODEF),Q(LID
Cbrc   1IR),Q(LNCURV),Q(LCOEF),Q(LVO),Q(LINMEH),MFPTS,MDPTS)
Cbrc
```

```
C
C.... READ IN OUTPUT DATA ****
C
.  READ (5,905) NPFREQ, NPRU, NPRS, NPIC, NANG, NPSEC
C
C.... ALLOCATE Q ARRAY FOR OUTPUT DATA ****
C
   NPTS=MXSTEP/NPFREQ+2
   NPLOT = NPRU+NPRS+3*NPSEC
   LDEF=NPTS+LT
   LUOUT=LDEF+4*NANG
   LSOUT=NPRU/2+1+LUOUT
   LNPOUT=NPRS/2+1+LSOUT
   LGLABE=2*NPIC+LNPOUT
   IF (NPIC.LT.0)  LGLABE = LNPOUT+2
   LPSU = 20*NPLOT + LGLABE
   LUU=NPTS*NPLOT+LPSU
   NT = NPTS
   NDEF = NANG
   NUOUT = NPRU
   NSOUT = NPRS
   NNPOUT = NPIC
   IF (NPIC.LT.0)  NNPOUT=1
   NGLABE = NPLOT
   NPSU = NPLOT
C
C  READ INFO FOR SEC. BODIES FOR CONTAC AND SET INDEX TO Q
C
   IS=1
   IF(KONTRL(6).LE.0) IS=0
   LVBRD=LUU+NPRU
   LMBRD=LVBRD+IS*45
   LABRD=LMBRD+IS*45
   LADDMAS=LABRD+IS*45
   LNCONEL=LADDMAS+120*IS
   LIPOSS=LNCONEL+64*IS
   LNELCON=LIPOSS+1*IS
   LISEC=LNELCON+1 *IS
   LC=LISEC+6*KONTRL(6)
   LAREA=LC+IS*3
   LAEL=LAREA+IS*3
   LDIRCOS=LAEL+IS*15
   LIMPBRD=LDIRCOS+IS*15
   LIDEL=LIMPBRD+IS*15
   LVOLD=LIDEL+IS*15
   NUU = NPRU
   NVBRD = IS*45
   NMBRD = IS*45
   NABRD = IS*45
   NADDMAS = 120*IS
   NNCONEL = 64*IS
   NIPOSS = IS
   NNELCON = IS
   NISEC = 6*KONTRL(6)
   NC = IS*3
   NAREA = IS*3
   NAEL = IS*15
   NDIRCOS = IS*15
   NIMPBRD = IS*15
   NIDEL = IS*15
C
   SRNAME = ' READOU'
   CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
   CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
   WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
   WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
   WRITE(LUTRM,920) SRNAME, DH, DM, DS, DC
   WRITE(LUOUTP,920) SRNAME, DH, DM, DS, DC
   CALL READOU (Q(LUOUT),Q(LSOUT),Q(LNPOUT),Q(LGLABE),Q(LINMEH),
   1        Q(LIX),Q(LDEF),KONTRL(6),Q(LISEC))
   CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
   CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
   WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
   WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
   WRITE(LUTRM,921) SRNAME, DH, DM, DS, DC
   WRITE(LUOUTP,921) SRNAME, DH, DM, DS, DC
```

```
      LSS=LVOLD+N1
      LA=NPRS+LSS
      LNTYPE=NPTS+LA
      LTOTAL=NPLOT+LNTYPE
      MUD2=2*MUD
      IF(KONTRL(11).GE.1)
     1 WRITE(6,907) LFINT,LXC,LYC,LZC,LINMEH,LMESHN,LXO,LX1,LBLAMB,
     2          LVO,LAO,LA1,LSMASS,LFORCD,LFEXOD,LAUX,LINDEX,LIX,
     3          LAL,LDICOS,LE,LNODIS,LANGLE,LIPT,LSTRS,LSTRES,
     4          LSTRAI,LYIPT,LZIPT,LXLEN,LTHCK,LFTIME,LFFCN,
     5          LDTIME,LDFCN,LNODEF,LIDIR,LNCURV,LCOEF,LT,LUOUT,
     6          LSOUT,LNPOUT,LGLABE,LPSU,LUU,LSS,LA,LNTYPE,LTOTAL
      NVOLD = N1
      NSS = NPRS
      NA = NPTS
      NNTYPE = NPLOT
C
C   ALLOCATION OF Q ARRAY FOR SLIDING INTERFACES
C
      NOPT=KONTRL(4)
      LNCP=LTOTAL
      LNASN=5*NOPT+LNCP
      LDICOP=1.5*NOPT+LNASN
      LALPHA=9*NOPT+LDICOP
      LUP=9*NOPT+LALPHA
      LUP2=3*NOPT+LUP
      LNPNO=3*NOPT+LUP2
      LSEATK=NOPT/2+1+LNPNO
      LUPOLD=2*NOPT+LSEATK
      LVDAMP=3*NOPT+LUPOLD
      LUP1=NOPT+LVDAMP
      LTOTAL=3*NOPT+LUP1
      IF(KONTRL(11).GE.1) WRITE(6,910) LNCP,LNASN,LDICOP,LALPHA,LUP,
     1          LUP2,LNPNO,LSEATK,LUPOLD,LVDAMP,LUP1,LTOTAL
      NNCP = NOPT
      NNASN = 3*NOPT
      NDICOP = NOPT
      NALPHA = NOPT
      NUP = 3*NOPT
      NUP2 = 3*NOPT
      NNPNO = NOPT
      NSEATK = NOPT
      NUPOLD = 3*NOPT
      NVDAMP = NOPT
      NUP1 = 3*NOPT
      IF(LTOTAL.LE.MAXQ) THEN
       WRITE(6,909) LTOTAL
C
C.... CALL SOLVE FOR EXPLICT PROBLEM ****
C
       SRNAME = '   SOLVE'
       CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
       CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
       WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUTRM,920) SRNAME, DH, DM, DS, DC
       WRITE(LUOUTP,920) SRNAME, DH, DM, DS, DC
       CALL SOLVE (Q(LNODIS),Q(LSMASS),Q(LXC),Q(LYC),Q(LZC),Q(LIX),
     1          Q(LE),Q(LXO),Q(LX1),Q(LVO),Q(LAO),Q(LA1),Q(LFORCD),
     2          DQ(LFINT),Q(LBLAMB),Q(LDICOS),Q(LINMEH),
     3          Q(LAL),Q(LINDEX),Q(LSTRS),Q(LSTRAI),Q(LSTRES),
     4          Q(LIPT),Q(LFEXOD),Q(LNCP),Q(LNASN),Q(LDICOP),
     5          Q(LALPHA),Q(LUP),Q(LUP2),Q(LNPNO),Q(LSEATK),
     6          Q(LUPOLD),Q(LVDAMP),Q(LUP1),Q(LVOLD))
       CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
       CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
       WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUTRM,921) SRNAME, DH, DM, DS, DC
       WRITE(LUOUTP,921) SRNAME, DH, DM, DS, DC
       SRNAME = '   STOP'
       CALL GETTIM(DHR,DMIN,DSEC,DCENTS)
       CALL SUBTIM(DHR,HR,DMIN,MIN,DSEC,SEC,DCENTS,CENTS,DH,DM,DS,DC)
       WRITE(LUTRM,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUOUTP,920) SRNAME, DHR, DMIN, DSEC, DCENTS
       WRITE(LUTRM,920) SRNAME, DH, DM, DS, DC
```

```
      WRITE(LUOUTP,920) SRNAME, DH, DM, DS, DC
      STOP
      WRITE (6,912) LTOTAL
     END IF

     STOP
C
 901 FORMAT (20A4)
 902 FORMAT (1H1,10X,20A4)
 903 FORMAT (6I5,I6,I4,D10.3,I5)
 904 FORMAT (43H TOTAL LENGTH OF Q ARRAY ENTERING READIN IS,I5)
 905 FORMAT (16I5)
 907 FORMAT (43H THE FOLLOWING IS THE INDEXS TO THE Q ARRAY//9H LFINT
    1-,I5,9H LXC    -,I5,9H LYC    -,I5,9H LZC    -,I5,9H LINMEH -,I5/9
    2H LMESHN -,I5,9H LXO    -,I5,9H LX1    -,I5,9H LBLAMB -,I5,9H LVO
    3  -,I5/9H LAO    -,I5,9H LA1    -,I5,9H LSMASS -,I5,9H LFORCD -,I
    45,9H LFEXOD -,I5/9H LAUX   -,I5,9H LINDEX -,I5,9H LIX    -,I5,9H L
    5AL    -,I5,9H LDICOS -,I5/9H LE     -,I5,9H LNODIS -,I5,9H LANGLE
    6-,I5,9H LIPT   -,I5,9H LSTRS  -,I5,9H LSTRES -,I5/9H LSTRAI -,I5,9
    7H LYIPT  -,I5,9H LZIPT  -,I5,9H LXLEN  -,I5,9H LTHCK  -,I5/9H LFTI
    8ME -,I5,9H LFFCN  -,I5,9H LDTIME -,I5,9H LDFCN  -,I5,9H LNODEF -,I
    95/9H LIDIR  -,I5,9H LNCURV -,I5,9H LCOEF  -,I5/9H LT     -,I5,9H L
    $UOUT  -,I5/9H LSOUT  -,I5,9H LNPOUT -,I5,9H LGLABE -,I5,9H LPSU
    $-,I5,9H LUU    -,I5/9H LSS    -,I5,9H LA     -,I5,9H LNTYPE -,I5,9
    $H LTOTAL -,I5)
 908 FORMAT (49H TOTAL LENGTH OF Q ARRAY AFTER CALL TO ASSBLE IS , I5)
 909 FORMAT (/10X,27HTOTAL LENGTH OF Q ARRAY IS ,I6)
 910 FORMAT (44H ALLOCATION OF Q ARRAY FOR SLIDING INTERFACE/9H LNCP
    1-,I5,9H LNASN  -,I5,9H LDICOP -,I5,9H LALPHA -,I5,9H LUP    -,I5/9
    2H LUP2   -,I5,9H LNPNO  -,I5,9H LSEATK -,I5,9H LUPOLD -,I5,9H LVDA
    3MP -,I5/9H LUP1   -,I5,9H LTOTAL -,I5)
 912 FORMAT(1H0,27HREQUIRED LENGTH OF ARRAY = ,I5,21H EXECUTION TERMIN
    1ATED )
Cbrc
Cbrc  FORMATs 920 AND 921 ADDED TO PRINT TIMIMG INFORMATION
Cbrc
 920 FORMAT(//,5X,'******TIME OF CALL TO SR ',A8,': ',I2,':',I2,':',I2.
    + ':',I2,//)
 921 FORMAT(//,5X,'******TIME OF RETURN FROM SR ',A8,': ',I2,':',I2,
    +':',I2,':',I2,//)
      END
```

```
      COMMON /ADJUST/ NFINT,NXC,NYC,NZC,NINMEH,NMESHN,NXO,NX1,NBLAMB,
     1          NVO,NAO,NA1,NSMASS,NFORCD,NFEXOD,NAUX,NINDEX,
     2          NIX,NAL,NDICOS,NE,NNODIS,NANGLE,NXT,NYT,NZT,
     3          NIPT,NSTRS,NSTRES,NSTRAI,NYIPT,NZIPT,NXLEN,
     4          NTHCK,NFTIME,NFFCN,NDTIME,NDFCN,NNODEF,NIDIR,
     5          NNCURV,NCOEF,NT,NDEF,NUOUT,NSOUT,NNPOUT,
     6          NGLABE,NPSU,NUU,NVBRD,NMBRD,NABRD,NADDMAS,
     7          NNCONEL,NIPOSS,NNELCON,NISEC,NC,NAREA,NAEL,
     8          NDIRCOS,NIMPBRD,NIDEL,NVOLD,NSS,NA,NNTYPE,
     9          NNCP,NNASN,NDICOP,NALPHA,NUP,NUP2,NNPNO,
     A          NSEATK,NUPOLD,NVDAMP,NUP1,NNBLAM

      COMMON /ARRAY/ MAXQ, DUM1, Q(45000)

      COMMON /CONTRL/ KONTRL(16)

      COMMON /DYNAM/ DELT,TIMENP,MXSTEP,NTSTEP,TIME

      COMMON /INDEX/ LFINT,LXC,LYC,LZC,LINMEH,LMESHN,LXO,LX1,LBLAMB,LVO,
     1LAO,LA1,LSMASS,LFORCD,LFEXOD,LAUX,LINDEX,LIX,LAL,LDICOS,LE,LNODIS,
     2LANGLE,LIPT,LSTRS,LSTRES,LSTRAI,LYIPT,LZIPT,LXLEN,LTHCK,LFTIME,LFF
     3CN,LDTIME,LDFCN,LNODEF,LIDIR,LNCURV,LCOEF,LT,LUOUT,LSOUT,LNPOUT,LG
     4LABE,LPSU,LUU,LSS,LA,LNTYPE,LNCP,LNASN,LDICOP,LALPHA,LUP,LUP2,LNPN
     5O,LSEATK,LUPOLD,LVDAMP,LUP1,LVBRD,LMBRD,LABRD,LADDMAS,LNCONEL,
     . LIPOSS,LNELCON,LISEC,LC,LAREA,LAEL,LDIRCOS,LIMPBRD,LIDEL,LVOLD,
     . LTOTAL,LDEF

      COMMON /MATRIX/ NAM,NB,NR

      COMMON /NUMINT/ NUMSEC,MAXIPT

      COMMON /OUTPA/ NPRU, NPRS, NPFREQ, NPIC, NPLOT, NPTS, NANG, NPSEC

      COMMON /PRESBC/ NFLC,MFPTS,NFNODE,NDLC,MDPTS,NDNODE,IVNODE

      COMMON /SIZE/ NNODE,NPRI,NAXOR,NELE,NUMMAT,NUMDIS,NPDIS,NDGREE,NOD
     1          MAX,MUD
```

APPENDIX B

VISUAL BASIC CODE FOR THE INPUT FILE INTERFACE

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HSM User Interface Instructions

Installing HSM

An installation program is provided to install HSM. To begin the installation, insert HSM disk #1 into floppy drive A:, select Run from the Windows File Menu, and then type in A:\SETUP.EXE. Click on OK and follow the instructions given on the screen. You will be prompted when to insert disk #2 into drive A. When the installation process in complete the HSM group and icon will be created for you.

Running HSM

After the HSM software is installed, follow these steps to run HSM.

1. Double click on the HSM icon and the program will start.

2. Select an input file using the **Open** option on the **File** menu.

3. Make any editing changes required to the data from the input file.
   Note: Some data cannot be changed without also changing the source code for the Fortran HSM program and then recompiling.

4. Save the revised input file using the **Save** option on the **File** menu.

5. Select **Solve** from the main menu to run the Fortran HSM program.
   A blank DOS screen will appear while this program in running. If a slow processor is being used, this program will require several minutes to complete execution.

6. Select **Plot** from the main menu to display the plots from the output file.

7. Exit HSM by selecting **Exit** on the **File** menu.

```
Option Explicit

Sub Form_Load ()

    'This routine initialize variables and grids
    '  Subroutines called:  Materials
    '                       NodeData
    '                       Element
    '                       Displace
    '                       Motion
    '                       Stress
    '                       Picture
    '                       FunctionSpec
    '                       Plane
    '                       Spine

    NUMMAT = 1
    tabHSMInput.CurrTab = 0

    'setup grids for input file
    Call Materials
    Call NodeData
    Call Element
    Call Displace
    Call Motion
    Call Stress
    Call Picture
    Call FunctionSpec
    Call Plane
    Call Spine

End Sub

Sub mnuFileExit_Click ()

    End

End Sub

Sub mnuFileOpen_Click ()

    Call ReadInputFile

End Sub

Sub mnuFileSave_Click ()

    Call SaveInputFile

End Sub

Sub mnuPlot_Click ()

    Call ReadOutFile

End Sub

Sub mnuSolve_Click ()

    'This routine copies the current input file to hsm.inp and shells to DOS
    'to run the Fortran executable HSM program.

    Dim x     'return value from shell

    If Infile <> "" Then
       FileCopy Infile, App.Path & "\hsm.inp"
```

```
      ChDir "c:\hsm"
      x = Shell(App.Path & "\brchsm.exe", 2)
      While GetModuleUsage(x) > 0
         DoEvents
      Wend
   End If

End Sub
```

C:\HSMINPUT\PLOT.FRM 11/30/95 11:32:26 AM

```
Option Explicit

Sub cmdClose_Click ()
   frmPlot.Hide
End Sub
```

C:\HSMINPUT\HSM.BAS 11/30/95 11:32:52 AM

```
Option Explicit
```

Sub Displace ()

```
    'label columns for displacement nodes
    frmHSMInput.tblDisplace.ColumnName(1) = "NODE"
    frmHSMInput.tblDisplace.ColumnName(2) = "TRANS. X DF"
    frmHSMInput.tblDisplace.ColumnName(3) = "TRANS. Y DF"
    frmHSMInput.tblDisplace.ColumnName(4) = "TRANS. Z DF"
    frmHSMInput.tblDisplace.ColumnName(5) = "ROT. ABOUT X"
    frmHSMInput.tblDisplace.ColumnName(6) = "ROT. ABOUT Y"
    frmHSMInput.tblDisplace.ColumnName(7) = "ROT. ABOUT Z"

    'size columns for displacement nodes
    frmHSMInput.tblDisplace.ColumnSize(1) = 4
    frmHSMInput.tblDisplace.ColumnSize(2) = 1
    frmHSMInput.tblDisplace.ColumnSize(3) = 1
    frmHSMInput.tblDisplace.ColumnSize(4) = 1
    frmHSMInput.tblDisplace.ColumnSize(5) = 1
    frmHSMInput.tblDisplace.ColumnSize(6) = 1
    frmHSMInput.tblDisplace.ColumnSize(7) = 1
    frmHSMInput.tblDisplace.ColumnWidth(1) = 6
    frmHSMInput.tblDisplace.ColumnWidth(2) = 16
    frmHSMInput.tblDisplace.ColumnWidth(3) = 16
    frmHSMInput.tblDisplace.ColumnWidth(4) = 16
    frmHSMInput.tblDisplace.ColumnWidth(5) = 16
    frmHSMInput.tblDisplace.ColumnWidth(6) = 16
    frmHSMInput.tblDisplace.ColumnWidth(7) = 16
```

End Sub

Sub Element ()

```
    'label columns for elements
    frmHSMInput.tblElements.ColumnName(1) = "No."
    frmHSMInput.tblElements.ColumnName(2) = "N1"
    frmHSMInput.tblElements.ColumnName(3) = "N2"
    frmHSMInput.tblElements.ColumnName(4) = "N3"
    frmHSMInput.tblElements.ColumnName(5) = "N4"
    frmHSMInput.tblElements.ColumnName(6) = "N5"
    frmHSMInput.tblElements.ColumnName(7) = "N6"
    frmHSMInput.tblElements.ColumnName(8) = "N7"
    frmHSMInput.tblElements.ColumnName(9) = "COOR"
    frmHSMInput.tblElements.ColumnName(10) = "MTYP"
    frmHSMInput.tblElements.ColumnName(11) = "ETYP"
    frmHSMInput.tblElements.ColumnName(12) = "N1"
    frmHSMInput.tblElements.ColumnName(13) = "N2"
    frmHSMInput.tblElements.ColumnName(14) = "N3"
    frmHSMInput.tblElements.ColumnName(15) = "N4"
    frmHSMInput.tblElements.ColumnName(16) = "COOR"

    'size columns for elements
    frmHSMInput.tblElements.ColumnSize(1) = 5
    frmHSMInput.tblElements.ColumnSize(2) = 5
    frmHSMInput.tblElements.ColumnSize(3) = 5
    frmHSMInput.tblElements.ColumnSize(4) = 5
    frmHSMInput.tblElements.ColumnSize(5) = 5
    frmHSMInput.tblElements.ColumnSize(6) = 5
    frmHSMInput.tblElements.ColumnSize(7) = 5
    frmHSMInput.tblElements.ColumnSize(8) = 5
    frmHSMInput.tblElements.ColumnSize(9) = 5
    frmHSMInput.tblElements.ColumnSize(10) = 5
    frmHSMInput.tblElements.ColumnSize(11) = 5
    frmHSMInput.tblElements.ColumnSize(12) = 5
    frmHSMInput.tblElements.ColumnSize(13) = 5
    frmHSMInput.tblElements.ColumnSize(14) = 5
    frmHSMInput.tblElements.ColumnSize(15) = 5
    frmHSMInput.tblElements.ColumnSize(16) = 5
    frmHSMInput.tblElements.ColumnWidth(1) = 8
    frmHSMInput.tblElements.ColumnWidth(2) = 12
    frmHSMInput.tblElements.ColumnWidth(3) = 12
```

```
    frmHSMInput.tblElements.ColumnWidth(4) = 12
    frmHSMInput.tblElements.ColumnWidth(5) = 12
    frmHSMInput.tblElements.ColumnWidth(6) = 1
    frmHSMInput.tblElements.ColumnWidth(7) = 1
    frmHSMInput.tblElements.ColumnWidth(8) = 1
    frmHSMInput.tblElements.ColumnWidth(9) = 12
    frmHSMInput.tblElements.ColumnWidth(10) = 12
    frmHSMInput.tblElements.ColumnWidth(11) = 12
    frmHSMInput.tblElements.ColumnWidth(12) = 1
    frmHSMInput.tblElements.ColumnWidth(13) = 12
    frmHSMInput.tblElements.ColumnWidth(14) = 1
    frmHSMInput.tblElements.ColumnWidth(15) = 1
    frmHSMInput.tblElements.ColumnWidth(16) = 12

End Sub

Sub FunctionSpec ()

    'label columns for functions specs
    frmHSMInput.tblFuncSpec.ColumnName(1) = "  TIME t"
    frmHSMInput.tblFuncSpec.ColumnName(2) = "  f(t)"
    frmHSMInput.tblFuncSpec.ColumnName(3) = "  f'(t)"

    'size columns for materials properties
    frmHSMInput.tblFuncSpec.ColumnSize(1) = 10
    frmHSMInput.tblFuncSpec.ColumnSize(2) = 10
    frmHSMInput.tblFuncSpec.ColumnSize(3) = 10
    frmHSMInput.tblFuncSpec.ColumnWidth(1) = 15
    frmHSMInput.tblFuncSpec.ColumnWidth(2) = 15
    frmHSMInput.tblFuncSpec.ColumnWidth(3) = 15

End Sub

Sub Materials ()

    'label columns for materials properties
    frmHSMInput.tblMatProp.ColumnName(1) = "MTYP"
    frmHSMInput.tblMatProp.ColumnName(2) = "LTYP"
    frmHSMInput.tblMatProp.ColumnName(3) = "E1"
    frmHSMInput.tblMatProp.ColumnName(4) = "E2"
    frmHSMInput.tblMatProp.ColumnName(5) = "E3"
    frmHSMInput.tblMatProp.ColumnName(6) = "E4"
    frmHSMInput.tblMatProp.ColumnName(7) = "E5"
    frmHSMInput.tblMatProp.ColumnName(8) = "E6"
    frmHSMInput.tblMatProp.ColumnName(9) = "E7"
    frmHSMInput.tblMatProp.ColumnName(10) = "E8"
    frmHSMInput.tblMatProp.ColumnName(11) = "E9"
    frmHSMInput.tblMatProp.ColumnName(12) = "E10"
    frmHSMInput.tblMatProp.ColumnName(13) = "E11"
    frmHSMInput.tblMatProp.ColumnName(14) = "E12"

    'size columns for materials properties
    frmHSMInput.tblMatProp.ColumnSize(1) = 5
    frmHSMInput.tblMatProp.ColumnSize(2) = 5
    frmHSMInput.tblMatProp.ColumnSize(3) = 10
    frmHSMInput.tblMatProp.ColumnSize(4) = 10
    frmHSMInput.tblMatProp.ColumnSize(5) = 10
    frmHSMInput.tblMatProp.ColumnSize(6) = 10
    frmHSMInput.tblMatProp.ColumnSize(7) = 10
    frmHSMInput.tblMatProp.ColumnSize(8) = 10
    frmHSMInput.tblMatProp.ColumnSize(9) = 10
    frmHSMInput.tblMatProp.ColumnSize(10) = 10
    frmHSMInput.tblMatProp.ColumnSize(11) = 10
    frmHSMInput.tblMatProp.ColumnSize(12) = 10
    frmHSMInput.tblMatProp.ColumnSize(13) = 10
    frmHSMInput.tblMatProp.ColumnSize(14) = 10
    frmHSMInput.tblMatProp.ColumnWidth(1) = 8
    frmHSMInput.tblMatProp.ColumnWidth(2) = 8
    frmHSMInput.tblMatProp.ColumnWidth(3) = 12
    frmHSMInput.tblMatProp.ColumnWidth(4) = 12
    frmHSMInput.tblMatProp.ColumnWidth(5) = 12
    frmHSMInput.tblMatProp.ColumnWidth(6) = 12
    frmHSMInput.tblMatProp.ColumnWidth(7) = 12
    frmHSMInput.tblMatProp.ColumnWidth(8) = 12
    frmHSMInput.tblMatProp.ColumnWidth(9) = 12
```

```
    frmHSMInput.tblMatProp.ColumnWidth(10) = 12
    frmHSMInput.tblMatProp.ColumnWidth(11) = 12
    frmHSMInput.tblMatProp.ColumnWidth(12) = 12
    frmHSMInput.tblMatProp.ColumnWidth(13) = 12
    frmHSMInput.tblMatProp.ColumnWidth(14) = 12

    'setup edit masks for materials properties
    frmHSMInput.tblMatProp.EditMask(3) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(4) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(5) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(6) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(7) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(8) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(9) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(10) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(11) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(12) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(13) = "Scientific"
    frmHSMInput.tblMatProp.EditMask(14) = "Scientific"

End Sub

Sub Motion ()

    'label columns for motion lines
    frmHSMInput.tblMotion.ColumnName(1) = "UOUT"
    frmHSMInput.tblMotion.ColumnName(2) = "J"
    frmHSMInput.tblMotion.ColumnName(3) = "K"
    frmHSMInput.tblMotion.ColumnName(4) = "L"
    frmHSMInput.tblMotion.ColumnName(5) = "LABEL"

    'size columns for motion lines
    frmHSMInput.tblMotion.ColumnSize(1) = 7
    frmHSMInput.tblMotion.ColumnSize(2) = 1
    frmHSMInput.tblMotion.ColumnSize(3) = 1
    frmHSMInput.tblMotion.ColumnSize(4) = 1
    frmHSMInput.tblMotion.ColumnSize(5) = 40
    frmHSMInput.tblMotion.ColumnWidth(1) = 10
    frmHSMInput.tblMotion.ColumnWidth(2) = 5
    frmHSMInput.tblMotion.ColumnWidth(3) = 5
    frmHSMInput.tblMotion.ColumnWidth(4) = 5
    frmHSMInput.tblMotion.ColumnWidth(5) = 40

End Sub

Sub NodeData ()

    'label columns for nodal data
    frmHSMInput.tblNodalData.ColumnName(1) = "Node"
    frmHSMInput.tblNodalData.ColumnName(2) = "I"
    frmHSMInput.tblNodalData.ColumnName(3) = "L"
    frmHSMInput.tblNodalData.ColumnName(4) = "N"
    frmHSMInput.tblNodalData.ColumnName(5) = "X-ORD"
    frmHSMInput.tblNodalData.ColumnName(6) = "Y-ORD"
    frmHSMInput.tblNodalData.ColumnName(7) = "Z-ORD"
    frmHSMInput.tblNodalData.ColumnName(8) = "TMASS(1)"
    frmHSMInput.tblNodalData.ColumnName(9) = "TMASS(2)"
    frmHSMInput.tblNodalData.ColumnName(10) = "TMASS(3)"
    frmHSMInput.tblNodalData.ColumnName(11) = "TMASS(4)"

    'size columns for nodal data
    frmHSMInput.tblNodalData.ColumnSize(1) = 5
    frmHSMInput.tblNodalData.ColumnSize(2) = 1
    frmHSMInput.tblNodalData.ColumnSize(3) = 1
    frmHSMInput.tblNodalData.ColumnSize(4) = 1
    frmHSMInput.tblNodalData.ColumnSize(5) = 10
    frmHSMInput.tblNodalData.ColumnSize(6) = 10
    frmHSMInput.tblNodalData.ColumnSize(7) = 10
    frmHSMInput.tblNodalData.ColumnSize(8) = 10
    frmHSMInput.tblNodalData.ColumnSize(9) = 10
    frmHSMInput.tblNodalData.ColumnSize(10) = 10
    frmHSMInput.tblNodalData.ColumnSize(11) = 10
    frmHSMInput.tblNodalData.ColumnWidth(1) = 8
    frmHSMInput.tblNodalData.ColumnWidth(2) = 5
    frmHSMInput.tblNodalData.ColumnWidth(3) = 5
```

```
    frmHSMInput.tblNodalData.ColumnWidth(4) = 5
    frmHSMInput.tblNodalData.ColumnWidth(5) = 12
    frmHSMInput.tblNodalData.ColumnWidth(6) = 12
    frmHSMInput.tblNodalData.ColumnWidth(7) = 12
    frmHSMInput.tblNodalData.ColumnWidth(8) = 12
    frmHSMInput.tblNodalData.ColumnWidth(9) = 12
    frmHSMInput.tblNodalData.ColumnWidth(10) = 12
    frmHSMInput.tblNodalData.ColumnWidth(11) = 12

    'setup edit masks for nodal data
    frmHSMInput.tblNodalData.EditMask(8) = "Scientific"
    frmHSMInput.tblNodalData.EditMask(9) = "Scientific"
    frmHSMInput.tblNodalData.EditMask(10) = "Scientific"
    frmHSMInput.tblNodalData.EditMask(11) = "Scientific"

End Sub

Sub Picture ()

    'label columns for picture lines
    frmHSMInput.tblPicLines.ColumnName(1) = "NPOUT"
    frmHSMInput.tblPicLines.ColumnName(2) = "KON"

    'size columns for picture lines
    frmHSMInput.tblPicLines.ColumnSize(1) = 10
    frmHSMInput.tblPicLines.ColumnSize(2) = 10
    frmHSMInput.tblPicLines.ColumnWidth(1) = 15
    frmHSMInput.tblPicLines.ColumnWidth(2) = 15

End Sub

Sub Plane ()

    'label columns for plane lines
    frmHSMInput.tblPlaneLines.ColumnName(1) = "  NODE "
    frmHSMInput.tblPlaneLines.ColumnName(2) = "  # Contact "
    frmHSMInput.tblPlaneLines.ColumnName(3) = "  DIR. COS x "
    frmHSMInput.tblPlaneLines.ColumnName(4) = "  DIR. COS y "
    frmHSMInput.tblPlaneLines.ColumnName(5) = "  DIR. COS z "
    frmHSMInput.tblPlaneLines.ColumnName(6) = "  LINEAR "
    frmHSMInput.tblPlaneLines.ColumnName(7) = "  CUBIC "
    frmHSMInput.tblPlaneLines.ColumnName(8) = "  VISCOUS "
    frmHSMInput.tblPlaneLines.ColumnName(9) = "  First Node "
    frmHSMInput.tblPlaneLines.ColumnName(10) = "  Last Node "
    frmHSMInput.tblPlaneLines.ColumnName(11) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(12) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(13) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(14) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(15) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(16) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(17) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(18) = "   "
    frmHSMInput.tblPlaneLines.ColumnName(19) = "  x1 "
    frmHSMInput.tblPlaneLines.ColumnName(20) = "  y1 "
    frmHSMInput.tblPlaneLines.ColumnName(21) = "  z1 "
    frmHSMInput.tblPlaneLines.ColumnName(22) = "  x2 "
    frmHSMInput.tblPlaneLines.ColumnName(23) = "  y2 "
    frmHSMInput.tblPlaneLines.ColumnName(24) = "  z2 "
    frmHSMInput.tblPlaneLines.ColumnName(25) = "  x3 "
    frmHSMInput.tblPlaneLines.ColumnName(26) = "  y3 "
    frmHSMInput.tblPlaneLines.ColumnName(27) = "  z3 "

    'size columns for plane lines
    frmHSMInput.tblPlaneLines.ColumnSize(1) = 5
    frmHSMInput.tblPlaneLines.ColumnSize(2) = 5
    frmHSMInput.tblPlaneLines.ColumnSize(3) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(4) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(5) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(6) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(7) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(8) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(9) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(10) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(11) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(12) = 1
```

```
    frmHSMInput.tblPlaneLines.ColumnSize(13) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(14) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(15) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(16) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(17) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(18) = 1
    frmHSMInput.tblPlaneLines.ColumnSize(19) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(20) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(21) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(22) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(23) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(24) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(25) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(26) = 10
    frmHSMInput.tblPlaneLines.ColumnSize(27) = 10
    frmHSMInput.tblPlaneLines.ColumnWidth(1) = 8
    frmHSMInput.tblPlaneLines.ColumnWidth(2) = 5
    frmHSMInput.tblPlaneLines.ColumnWidth(3) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(4) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(5) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(6) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(7) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(8) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(9) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(10) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(11) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(12) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(13) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(14) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(15) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(16) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(17) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(18) = 1
    frmHSMInput.tblPlaneLines.ColumnWidth(19) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(20) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(21) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(22) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(23) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(24) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(25) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(26) = 12
    frmHSMInput.tblPlaneLines.ColumnWidth(27) = 12

End Sub

Sub Spine ()

    'label columns for spine
    frmHSMInput.tblSpine.ColumnName(1) = "    NODE "
    frmHSMInput.tblSpine.ColumnName(2) = "    AXIAL COMP"
    frmHSMInput.tblSpine.ColumnName(3) = "  LAT. BENDING"
    frmHSMInput.tblSpine.ColumnName(4) = "ANT/POST BENDING"

    'size columns for spine
    frmHSMInput.tblSpine.ColumnSize(1) = 5
    frmHSMInput.tblSpine.ColumnSize(2) = 5
    frmHSMInput.tblSpine.ColumnSize(3) = 5
    frmHSMInput.tblSpine.ColumnSize(4) = 5
    frmHSMInput.tblSpine.ColumnWidth(1) = 10
    frmHSMInput.tblSpine.ColumnWidth(2) = 20
    frmHSMInput.tblSpine.ColumnWidth(3) = 20
    frmHSMInput.tblSpine.ColumnWidth(4) = 20

End Sub

Sub Stress ()

    'label columns for stress lines
    frmHSMInput.tblStress.ColumnName(1) = "SOUT"
    frmHSMInput.tblStress.ColumnName(2) = "I1"
    frmHSMInput.tblStress.ColumnName(3) = "I2"
    frmHSMInput.tblStress.ColumnName(4) = "I3"
    frmHSMInput.tblStress.ColumnName(5) = "M"
    frmHSMInput.tblStress.ColumnName(6) = "N"
    frmHSMInput.tblStress.ColumnName(7) = "LABEL"
```

```
'size columns for stress lines
    frmHSMInput.tblStress.ColumnSize(1) = 5
    frmHSMInput.tblStress.ColumnSize(2) = 1
    frmHSMInput.tblStress.ColumnSize(3) = 1
    frmHSMInput.tblStress.ColumnSize(4) = 1
    frmHSMInput.tblStress.ColumnSize(5) = 1
    frmHSMInput.tblStress.ColumnSize(6) = 1
    frmHSMInput.tblStress.ColumnSize(7) = 40
    frmHSMInput.tblStress.ColumnWidth(1) = 10
    frmHSMInput.tblStress.ColumnWidth(2) = 5
    frmHSMInput.tblStress.ColumnWidth(3) = 5
    frmHSMInput.tblStress.ColumnWidth(4) = 5
    frmHSMInput.tblStress.ColumnWidth(5) = 5
    frmHSMInput.tblStress.ColumnWidth(6) = 5
    frmHSMInput.tblStress.ColumnWidth(7) = 40

End Sub
```

```
Option Explicit

Global Infile As String          ' name of input file
Global Outfile As String         ' name of output file

' parameter variables
Global NNODE As Integer          ' number of nodes in the model
Global NPRI As Integer           ' number of primary nodes in the model
Global NAXOR As Integer          ' number of axis orientation nodes in the model
Global NELE As Long              ' number of elements in the model
Global NUMMAT As Long            ' number of different element section and material types
Global NUMDIS As Integer         ' number of nodes at which any displacement components are specified
Global MXSTEP As Long            ' number of time steps to be taken
Global NDGREE As Integer         ' number of degrees of freedom per node
Global DELT As Double            ' time increment
Global NODMAX As Integer         ' largest node number in model

' input variables
Global NLOAD As Integer          ' load
Global NIC As Integer            ' displacement

' output control variables
Global NPFREQ As Integer         ' frequency of output
Global NPRU As Integer           ' number of motion output lines
Global NPRS As Integer           ' number of stress output lines
Global NPIC As Integer           ' number of complete output pictures
Global NANG As Integer           ' used when ELMPLT is desired in output
Global NUMSEC As Integer         ' sets of cross-sectional geometries
Global NPTS As Integer           ' number of points where the motion functions value and derivative are
»» specified
Global F1 As Double              ' integration constant for first integration
Global F2 As Double              ' integration constant for second integration
Global JSTART As Integer         ' inferior disc element for bottommost vertebral level considered
Global JEND As Integer           ' superior disc element for uppermost vertebral level considered
Global NB As Integer             ' number of vertebrae
Global PLTDCD As Integer
Global PLTLAB As Integer
Global IOPTPLT As Integer
Global TOTALX As Integer         ' width of plot (x,z) view
Global TOTALY As Integer         ' width of plot (y,z) view
Global TOTALZ As Integer         ' height of plot
Global XNEG As Integer           ' distance of the origin from left side of plot
Global YNEG As Integer           ' distance of the origin from left side of plot
Global ZNEG As Integer           ' distance of the origin from bottom of plot

' array variables
Global KONTRL(16) As Integer     ' program control lines
Global NCP(2) As String          ' primary nodes associated with a plane
Global TITLE(3) As String        ' title for output
Global aryMAT() As String        ' material-section property lines
Global aryNOD() As String        ' nodal data lines
Global aryELE() As String        ' element data lines
Global aryDIS() As String        ' displacement lines
Global aryIPT() As String        ' cross section
Global aryMOT() As String        ' motion output lines
Global arySTR() As String        ' stress output lines
Global aryPIC() As String        ' output picture lines
Global aryFSL() As String        ' function specification lines
Global aryNOP() As String        ' plane identification lines
Global arySPN() As String        ' spinal injury function lines
Global aryVEC() As String        ' X-Bar, Y-Bar Vectors

Declare Function GetModuleUsage Lib "Kernel" (ByVal hModule As Integer) As Integer
```

Sub CrossSection (buffer)

```
    'This routine extracts fields from cross-sectional geometries lines

    Dim j As Integer     'counter
```

```
   For j = 1 To NUMSEC
      aryIPT(j) = Mid$(buffer, (j - 1) * 5 + 1, 5)
   Next j

End Sub

Sub Displacement (buffer, i)

   'This routine extracts fields from prescribed displacement lines

   aryDIS(i, 1) = Mid$(buffer, 1, 4)      ' node number
   aryDIS(i, 2) = Mid$(buffer, 5, 1)      ' translational x
   aryDIS(i, 3) = Mid$(buffer, 6, 1)      ' translational y
   aryDIS(i, 4) = Mid$(buffer, 7, 1)      ' translational z
   aryDIS(i, 5) = Mid$(buffer, 8, 1)      ' rotation x
   aryDIS(i, 6) = Mid$(buffer, 9, 1)      ' rotation y
   aryDIS(i, 7) = Mid$(buffer, 10, 1)     ' rotation z

End Sub

Sub Elements (buffer, i)

   'This routine extracts fields from element data lines

   aryELE(i, 1) = Mid$(buffer, 1, 5)      ' node number
   aryELE(i, 2) = Mid$(buffer, 6, 5)      ' Node I
   aryELE(i, 3) = Mid$(buffer, 11, 5)     ' Node J
   aryELE(i, 4) = Mid$(buffer, 16, 5)     ' primary node for I
   aryELE(i, 5) = Mid$(buffer, 21, 5)     ' primary node for J
   aryELE(i, 6) = Mid$(buffer, 26, 5)     ' not used
   aryELE(i, 7) = Mid$(buffer, 31, 5)     ' not used
   aryELE(i, 8) = Mid$(buffer, 36, 5)     ' not used
   aryELE(i, 9) = Mid$(buffer, 41, 5)     ' Node K
   aryELE(i, 10) = Mid$(buffer, 46, 5)    ' material type
   aryELE(i, 11) = Mid$(buffer, 51, 5)    ' element type
   aryELE(i, 12) = Mid$(buffer, 56, 5)    ' not used
   aryELE(i, 13) = Mid$(buffer, 61, 5)    ' number of sliding node pairs
   aryELE(i, 14) = Mid$(buffer, 66, 5)    ' not used
   aryELE(i, 15) = Mid$(buffer, 71, 5)    ' not used
   aryELE(i, 16) = Mid$(buffer, 76, 5)    ' level

End Sub

Function FormatNum (num, w) As String

   'This function converts a number to a string and pads
   'it with blanks on the left to achieve width w.
   '  num = number to convert
   '  w   = desired width

   Dim str1 As String

   str1 = Mid$(Str$(num), 2)
   While (Len(str1) < w)
      str1 = " " & str1
   Wend
   FormatNum = str1

End Function

Sub ICIF (buffer, i)

   'This routine extracts fields from ICIF data lines

   aryFSL(i, 1) = Mid$(buffer, 1, 10)     ' Time t
   aryFSL(i, 2) = Mid$(buffer, 11, 10)    ' motion function value at time t
   aryFSL(i, 3) = Mid$(buffer, 21, 10)    ' derivative of function at time t

End Sub
```

```
Sub MaterialPropertyLine1 (buffer, i)

  'This routine extracts fields from material property lines (type 1)

  aryMAT(i, 1) = Mid$(buffer, 1, 5)       ' MTYP
  aryMAT(i, 2) = Mid$(buffer, 6, 5)       ' LTYP

End Sub

Sub MaterialPropertyLine2 (buffer, i)

  'This routine extracts fields from material property lines (type 1)

  aryMAT(i, 3) = Mid$(buffer, 1, 10)        ' E(1,MTYP)
  aryMAT(i, 4) = Mid$(buffer, 11, 10)       ' E(2,MTYP)
  aryMAT(i, 5) = Mid$(buffer, 21, 10)       ' E(3,MTYP)
  aryMAT(i, 6) = Mid$(buffer, 31, 10)       ' E(4,MTYP)
  aryMAT(i, 7) = Mid$(buffer, 41, 10)       ' E(5,MTYP)
  aryMAT(i, 8) = Mid$(buffer, 51, 10)       ' E(6,MTYP)

End Sub

Sub MaterialPropertyLine3 (buffer, i)

  'This routine extracts fields from material property lines (type 1)

  aryMAT(i, 9) = Mid$(buffer, 1, 10)        ' E(7,MTYP)
  aryMAT(i, 10) = Mid$(buffer, 11, 10)      ' E(8,MTYP)
  aryMAT(i, 11) = Mid$(buffer, 21, 10)      ' E(9,MTYP)
  aryMAT(i, 12) = Mid$(buffer, 31, 10)      ' E(10,MTYP)
  aryMAT(i, 13) = Mid$(buffer, 41, 10)      ' E(11,MTYP)
  aryMAT(i, 14) = Mid$(buffer, 51, 10)      ' E(12,MTYP)

End Sub

Sub MotionLines (buffer, i)

  'This routine extracts fields from motion output lines

  aryMOT(i, 1) = Mid$(buffer, 1, 7)       ' node number
  aryMOT(i, 2) = Mid$(buffer, 8, 1)       ' component number of kinematic variable to be output
  aryMOT(i, 3) = Mid$(buffer, 9, 1)       ' displacement, velocity, or acceleration (0,1,2)
  aryMOT(i, 4) = Mid$(buffer, 10, 1)      ' plot control (0-4)
  aryMOT(i, 5) = Mid$(buffer, 21, 40)     ' label

End Sub

Sub NodalData (buffer, i)

  'This routine extracts fields from nodal data lines

  aryNOD(i, 1) = Mid$(buffer, 1, 5)       ' node number
  aryNOD(i, 2) = Mid$(buffer, 6, 1)       ' coordinate type
  aryNOD(i, 3) = Mid$(buffer, 7, 1)       ' generation level
  aryNOD(i, 4) = Mid$(buffer, 10, 1)      ' Secondary/Primary
  aryNOD(i, 5) = Mid$(buffer, 11, 10)     ' x coordinate
  aryNOD(i, 6) = Mid$(buffer, 21, 10)     ' y coordinate
  aryNOD(i, 7) = Mid$(buffer, 31, 10)     ' z coordinate
  aryNOD(i, 8) = Mid$(buffer, 41, 10)     ' TMASS(1)
  aryNOD(i, 9) = Mid$(buffer, 51, 10)     ' TMASS(2)
  aryNOD(i, 10) = Mid$(buffer, 61, 10)    ' TMASS(3)
  aryNOD(i, 11) = Mid$(buffer, 71, 10)    ' TMASS(4)

End Sub

Sub OutputData (buffer)

  'This routine extracts fields from the output data line
```

```
Dim temp As Integer      'temporary variable

NPFREQ = CInt(Mid$(buffer, 1, 5))                   ' frequency of output
frmHSMInput.txtNPFREQ = Mid$(buffer, 1, 5)
NPRU = CInt(Mid$(buffer, 6, 5))                     ' number of motion output lines
frmHSMInput.txtNPRU = Mid$(buffer, 6, 5)
NPRS = CInt(Mid$(buffer, 11, 5))                    ' number of stress output lines
frmHSMInput.txtNPRS = Mid$(buffer, 11, 5)
If Len(buffer) > 15 Then
   If Mid$(buffer, 16, 5) <> Space$(5) Then
      NPIC = CInt(Mid$(buffer, 16, 5))              ' number of complete output pictures
   End If
   frmHSMInput.txtNPIC = Mid$(buffer, 16, 5)
   If Mid$(buffer, 21, 5) <> Space$(5) Then
      NANG = CInt(Mid$(buffer, 21, 5))              ' used when ELMPLT is desired in output
   End If
   frmHSMInput.txtNANG = Mid$(buffer, 21, 5)
   frmHSMInput.txtNDREF = Mid$(buffer, 26, 5)
Else
   NPIC = 0
   NANG = 0
   frmHSMInput.txtNPIC = FormatNum(NPIC, 5)
   frmHSMInput.txtNANG = FormatNum(NANG, 5)
   frmHSMInput.txtNDREF = FormatNum(0, 5)
End If
```

End Sub

Sub ParameterLine (buffer)

```
'This routine extracts fields from a parameter line

frmHSMInput.txtNNODE = Mid$(buffer, 1, 5)
NNODE = CInt(Mid$(buffer, 1, 5))                    ' number of nodes in the model
frmHSMInput.txtNPRI = Mid$(buffer, 6, 5)
NPRI = CInt(Mid$(buffer, 6, 5))                     ' number of primary nodes in the model
frmHSMInput.txtNAXOR = Mid$(buffer, 11, 5)
NAXOR = CInt(Mid$(buffer, 11, 5))                   ' number of axis orientation modes in the model
frmHSMInput.txtNELE = Mid$(buffer, 16, 5)
NELE = CLng(Mid$(buffer, 16, 5))                    ' number of elements in the model
frmHSMInput.txtNUMMAT = Mid$(buffer, 21, 5)
NUMMAT = CLng(Mid$(buffer, 21, 5))                  ' number of different element section and material types
frmHSMInput.txtNUMDIS = Mid$(buffer, 26, 5)
NUMDIS = CInt(Mid$(buffer, 26, 5))                  ' number of nodes at which any displacement components
»» are specified
frmHSMInput.txtMXSTEP = Mid$(buffer, 31, 6)
MXSTEP = CLng(Mid$(buffer, 31, 6))                  ' number of time steps to be taken
frmHSMInput.txtNDGREE = Mid$(buffer, 37, 4)
NDGREE = CInt(Mid$(buffer, 37, 4))                  ' number of degrees of freedom per node
frmHSMInput.txtDELT = Mid$(buffer, 41, 10)
'DELT = CDbl(Mid$(buffer, 41, 10))                   ' time increment
frmHSMInput.txtNODMAX = Mid$(buffer, 51, 5)
NODMAX = Val(Mid$(buffer, 51, 5))                   ' largest node number in model
If NODMAX = 0 Then
   NODMAX = NNODE + NAXOR
   frmHSMInput.txtNODMAX = FormatNum(NODMAX, 5)
End If
```

End Sub

Sub PictureLines (buffer, i)

```
'This routine extracts fields from a output picture line

aryPIC(i, 1) = Mid$(buffer, 1, 10)      ' time step at which complete output picture is desired
aryPIC(i, 2) = Mid$(buffer, 11, 10)     ' KON (0-6)
```

End Sub

Sub PlaneID (filenumber, buffer, i)

```
'This routine reads plane identification lines and
```

```
'extracts the field data

   Dim j As Integer     'counter

   Line Input #filenumber, buffer
   aryNOP(i, 1) = Mid$(buffer, 1, 5)           ' primary node number designating the plane
   aryNOP(i, 2) = Mid$(buffer, 6, 5)           ' total number of primary nodes of the model which may
»» contact plane I
   aryNOP(i, 3) = Mid$(buffer, 11, 10)         ' direction cosine of acceleration vector with respect to
»» the global x-axis
   aryNOP(i, 4) = Mid$(buffer, 21, 10)         ' direction cosine of acceleration vector with respect to
»» the global y-axis
   aryNOP(i, 5) = Mid$(buffer, 31, 10)         ' direction cosine of acceleration vector with respect to
»» the global z-axis
   aryNOP(i, 6) = Mid$(buffer, 41, 10)         ' linear stiffness of elastic plane I
   aryNOP(i, 7) = Mid$(buffer, 51, 10)         ' cubic stiffness of elastic plane I
   aryNOP(i, 8) = Mid$(buffer, 61, 10)         ' fraction of viscous damping for plane I

   Line Input #filenumber, buffer
   If Val(aryNOP(i, 2)) > 0 Then
      For j = 1 To Val(aryNOP(i, 2))
         aryNOP(i, j + 8) = Mid$(buffer, (j - 1) * 5 + 1, 5)
      Next j
   Else
      aryNOP(i, 9) = Mid$(buffer, 1, 5)        'first primary node
      aryNOP(i, 10) = Mid$(buffer, 6, 5)       'last primary node
   End If
   Line Input #filenumber, buffer
   aryNOP(i, 19) = Mid$(buffer, 1, 10)         'x coordinate for point 1
   aryNOP(i, 20) = Mid$(buffer, 11, 10)        'y coordinate for point 1
   aryNOP(i, 21) = Mid$(buffer, 21, 10)        'z coordinate for point 1
   Line Input #filenumber, buffer
   aryNOP(i, 22) = Mid$(buffer, 1, 10)         'x coordinate for point 2
   aryNOP(i, 23) = Mid$(buffer, 11, 10)        'y coordinate for point 2
   aryNOP(i, 24) = Mid$(buffer, 21, 10)        'z coordinate for point 2
   Line Input #filenumber, buffer
   aryNOP(i, 25) = Mid$(buffer, 1, 10)         'x coordinate for point 3
   aryNOP(i, 26) = Mid$(buffer, 11, 10)        'y coordinate for point 3
   aryNOP(i, 27) = Mid$(buffer, 21, 10)        'z coordinate for point 3
   If KONTRL(14) = 1 Then
      Line Input #filenumber, buffer
   End If
```

End Sub

Sub PlotLines (filenumber, buffer)

```
   'This routine reads deformation configuration plot lines
   'and extracts the field values

   Dim i As Integer          ' counter
   Dim ICMND As Integer      ' number of command lines
   Dim xmin As String        ' x' mininum value
   Dim xmax As String        ' x' maximum value
   Dim ymin As String        ' y' minimum value
   Dim ymax As String        ' y' maximum value
   Dim zmin As String        ' z' minimum value
   Dim zmax As String        ' z' maximum value
   Dim IDN As Integer        ' fields in command line
   Dim NP As Integer         ' fields in command line
   Dim ID As String          ' fields in command line
   Dim strl As String        ' temporary string variable
   Dim CRLF As String        ' carriage return/line feed

   CRLF = Chr$(13) + Chr$(10)

   'line 15A - plot choices
   Line Input #filenumber, buffer
   PLTDCD = Val(Mid$(buffer, 1, 5))
   PLTLAB = Val(Mid$(buffer, 6, 5))
   IOPTPLT = Val(Mid$(buffer, 11, 5))
   frmHSMInput.txtPLTDCD.Text = Mid$(buffer, 1, 5)
   frmHSMInput.txtPLTLAB.Text = Mid$(buffer, 6, 5)
   frmHSMInput.txtIOPTPLT.Text = Mid$(buffer, 11, 5)
```

```
'line 15B - heading
 Line Input #filenumber, buffer
 TITLE(1) = Mid$(buffer, 1, 10)
 TITLE(2) = Mid$(buffer, 11, 10)
 TITLE(3) = Mid$(buffer, 21, 10)
 frmHSMInput.txtTitle2.Text = TITLE(1) + " " + TITLE(2) + " " + TITLE(3)

'line 15C - coordinates to be plotted
 Line Input #filenumber, buffer
 xmin = Mid$(buffer, 1, 10)
 xmax = Mid$(buffer, 11, 10)
 ymin = Mid$(buffer, 21, 10)
 ymax = Mid$(buffer, 31, 10)
 zmin = Mid$(buffer, 41, 10)
 zmax = Mid$(buffer, 51, 10)
 frmHSMInput.txtxmin = xmin
 frmHSMInput.txtxmax = xmax
 frmHSMInput.txtymin = ymin
 frmHSMInput.txtymax = ymax
 frmHSMInput.txtzmin = zmin
 frmHSMInput.txtzmax = zmax

'line 15D - size of plots and location of origin
 Line Input #filenumber, buffer
 TOTALX = Val(Mid$(buffer, 1, 10))
 TOTALY = Val(Mid$(buffer, 11, 10))
 TOTALZ = Val(Mid$(buffer, 21, 10))
 XNEG = Val(Mid$(buffer, 31, 10))
 YNEG = Val(Mid$(buffer, 41, 10))
 ZNEG = Val(Mid$(buffer, 51, 10))
 ICMND = Val(Mid$(buffer, 61, 5))
 frmHSMInput.txtTotalx.Text = Mid$(buffer, 1, 10)
 frmHSMInput.txtTotaly.Text = Mid$(buffer, 11, 10)
 frmHSMInput.txtTotalz.Text = Mid$(buffer, 21, 10)
 frmHSMInput.txtxneg.Text = Mid$(buffer, 31, 10)
 frmHSMInput.txtyneg.Text = Mid$(buffer, 41, 10)
 frmHSMInput.txtzneg.Text = Mid$(buffer, 51, 10)

'line 15E - Command Lines
strl = ""
For i = 1 To ICMND
   Line Input #filenumber, buffer
   IDN = Val(Mid$(buffer, 1, 2))
   NP = Val(Mid$(buffer, 3, 2))
   ID = Mid$(buffer, 5, 4)
   strl = strl + Mid$(buffer, 1, 2) + "  " + Mid$(buffer, 3, 2) + "  " + Mid$(buffer, 5, 4) + CRLF
Next i
frmHSMInput.txtCommand.Text = strl

End Sub

Sub ProgramControlLine (buffer)

   'This routine extracts fields from the program control line

   Dim temp As Integer      'temporary variable

   KONTRL(1) = Val(Mid$(buffer, 1, 5))          ' global or local coordinate option for secondary
»» nodes
   frmHSMInput.optKONTRL1(KONTRL(1)).Value = True
   If Mid$(buffer, 1, 5) = Space$(5) Then
      frmHSMInput.optKONTRL1(0) = True
   End If
   KONTRL(2) = Val(Mid$(buffer, 6, 5))          ' print option
   If KONTRL(2) = 0 Then
      frmHSMInput.chkKONTRL2.Value = True
   End If
   KONTRL(3) = Val(Mid$(buffer, 11, 5))         ' control parameter for initial body axes
   frmHSMInput.optKONTRL3(KONTRL(3)).Value = True
   KONTRL(4) = Val(Mid$(buffer, 16, 5))         ' number of sliding interface planes
   frmHSMInput.txtKONTRL4 = Mid$(buffer, 16, 5)
   KONTRL(5) = Val(Mid$(buffer, 21, 5))         ' beta parameter in the Newmark integration
   frmHSMInput.txtKONTRL5 = Mid$(buffer, 21, 5)
   KONTRL(6) = Val(Mid$(buffer, 26, 5))         ' number of secondary bodies for contact
   frmHSMInput.txtKONTRL6 = Mid$(buffer, 26, 5)
   KONTRL(7) = Val(Mid$(buffer, 31, 5))
```

```
' default node type
   frmHSMInput.optKONTRL7(KONTRL(7)).Value = True
   KONTRL(8) = Val(Mid$(buffer, 36, 5))              ' critical or viscous damping
   frmHSMInput.optKONTRL8(KONTRL(8)).Value = True
   KONTRL(9) = Val(Mid$(buffer, 41, 5))              ' type of integration
   frmHSMInput.optKONTRL9(KONTRL(9)).Value = True
   KONTRL(10) = Val(Mid$(buffer, 46, 5))             ' restart control
   frmHSMInput.txtKONTRL10 = Mid$(buffer, 46, 5)
   KONTRL(11) = Val(Mid$(buffer, 51, 5))             ' Q array output?
   frmHSMInput.optKONTRL11(KONTRL(11)).Value = True
   KONTRL(12) = Val(Mid$(buffer, 56, 5))             ' triangle place element
   frmHSMInput.optKONTRL12(KONTRL(12)).Value = True
   KONTRL(13) = Val(Mid$(buffer, 61, 5))             ' logical unit option
   KONTRL(14) = Val(Mid$(buffer, 66, 5))             ' contact with seat back?
   frmHSMInput.optKONTRL14(KONTRL(14)).Value = True
   KONTRL(15) = Val(Mid$(buffer, 71, 5))             ' injury potential determined?
   frmHSMInput.optKONTRL15(KONTRL(15)).Value = True
   KONTRL(16) = Val(Mid$(buffer, 76, 5))             '  preejection pilot alignment simulation?
   frmHSMInput.optKONTRL16(KONTRL(16)).Value = True

End Sub

Sub ReadInput (filenumber, buffer)

   'This routine reads each line of the input file that involves input data:
   '  Title, parameters, control, material properties, nodes, displacement,
   '  cross-sectional geometries, x-bar and y-bar vectors, and 7F lines.
   '  Subroutines called:  ParameterLine
   '                       ProgramControlLine
   '                       MaterialPropertyLine(1-3)
   '                       NodalData
   '                       Elements
   '                       Displacement
   '                       CrossSection
   '                       Vectors

   Dim i As Integer

   ' line 1 - TITLE
   Line Input #filenumber, buffer
   frmHSMInput.txtTITLE = buffer
   ' line 2 - Parameter Line
   Line Input #filenumber, buffer
   ParameterLine (buffer)
   ' line 3 - Program Control Line
   Line Input #filenumber, buffer
   ProgramControlLine (buffer)

   ' line 4 - Material Property Lines
   frmHSMInput.tblMatProp.Rows = NUMMAT
   ReDim aryMAT(NUMMAT, 14)
   For i = 1 To NUMMAT
      Line Input #filenumber, buffer
      Call MaterialPropertyLine1(buffer, i)
      Line Input #filenumber, buffer
      Call MaterialPropertyLine2(buffer, i)
      Line Input #filenumber, buffer
      Call MaterialPropertyLine3(buffer, i)
   Next i
   frmHSMInput.tblMatProp.Refresh

   ' line 5 - Nodal Data Lines
   frmHSMInput.tblNodalData.Rows = NNODE + NAXOR
   ReDim aryNOD(NNODE + NAXOR, 11)
   For i = 1 To NNODE + NAXOR
      Line Input #filenumber, buffer
      Call NodalData(buffer, i)
   Next i
   frmHSMInput.tblNodalData.Refresh

   ' line 6 - Element Data Lines
   frmHSMInput.tblElements.Rows = NELE
   ReDim aryELE(NELE, 16)
   For i = 1 To NELE
      Line Input #filenumber, buffer
```

```
      Call Elements(buffer, i)
   Next i
   frmHSMInput.tblElements.Refresh

   ' line 7 - Prescribed Displacement Lines
   frmHSMInput.tblDisplace.Rows = NUMDIS
   ReDim aryDIS(NUMDIS, 11)
   For i = 1 To NUMDIS
      Line Input #filenumber, buffer
      Call Displacement(buffer, i)
   Next i
   frmHSMInput.tblDisplace.Refresh

   'line 7B & 7C - Cross-Sectional Geometries Code
   If KONTRL(9) <> 0 Then
      Line Input #filenumber, buffer
      NUMSEC = Val(Mid$(buffer, 1, 5))
      If NUMSEC <> 0 Then
         ReDim aryIPT(NUMSEC)
         If NUMSEC <= 16 Then
            Line Input #filenumber, buffer
            Call CrossSection(buffer)
         End If
      End If
   End If

   'line 7D & 7E - X-Bar, Y-Bar Vectors
   If KONTRL(3) = 2 Then
      ReDim aryVEC(NPRI, 8)
      For i = 1 To NPRI
         Line Input #filenumber, buffer
         Call Vectors(buffer, i)
      Next i
   End If

   'line 7F
   Line Input #filenumber, buffer
   If Len(buffer) > 0 Then
      NLOAD = Val(Mid$(buffer, 1, 5))
      NIC = Val(Mid$(buffer, 6, 5))
   Else
      NLOAD = 0
      NIC = 0
   End If
```

End Sub

Sub ReadInputFile ()

```
   'This routine shows an open file dialog and allows the user to select
   'a .inp file.
   '  Subroutines called:  ReadInput
   '                       ReadOutput

   Dim buffer As String * 80       ' buffer for file read
   Dim filenumber As Integer       ' file handle

   ' erase arrays
   Erase aryMAT
   Erase aryNOD
   Erase aryELE
   Erase aryDIS
   Erase aryIPT
   Erase aryVEC
   Erase aryMOT
   Erase arySTR
   Erase aryPIC
   Erase aryFSL
   Erase aryNOP
   Erase arySPN

   'display open file dialog
   frmHSMInput.dlgFile.Filter = " (*.inp) | *.inp "
   frmHSMInput.dlgFile.Action = 1
   If frmHSMInput.dlgFile.Filename <> "" Then
```

```
      Infile = frmHSMInput.dlgFile.Filename
      'open file selected
      filenumber = FreeFile
      Open frmHSMInput.dlgFile.Filename For Input Access Read As #filenumber Len = 80
      On Error GoTo ErrorHandler
      'read input data
      Call ReadInput(filenumber, buffer)
      'read output data
      Call ReadOutput(filenumber, buffer)
      Close filenumber
   End If
   Exit Sub

ErrorHandler:
   If Err = 62 Then Exit Sub
   Resume Next
```

End Sub

Sub ReadOutput (filenumber, buffer)

```
   'This routine reads each line of the input file that involves output
   'specification:
   '  Output Control Lines, Motion Output Lines, Stress Output Lines,
   '  Complete Output Picture Lines, Deformation Amplification Factors,
   '  ICIF Data Lines, Plane Identification Lines, Spinal Injury Function
   '  Lines, and Deformation Configuration Plot Lines.
   '  Subroutines called:  OutputData
   '                       MotionLines
   '                       StressLines
   '                       PictureLines
   '                       PlotInfo
   '                       ICIF
   '                       PlaneID
   '                       SpinalInjury
   '                       PlotLines

   Dim i As Integer        'counter
   Dim j As Integer        'counter

   On Error GoTo ErrorHandlerO

   'line 8 - Output Control Line
   Line Input #filenumber, buffer
   Call OutputData(buffer)

   'line 9 - Motion Output Lines
   If NPRU > 0 Then
      frmHSMInput.tblMotion.Rows = NPRU
      ReDim aryMOT(NPRU, 5)
      For i = 1 To NPRU
         Line Input #filenumber, buffer
         Call MotionLines(buffer, i)
      Next i
      frmHSMInput.tblMotion.Refresh
   End If

   'line 10 - Stress Output Lines
   If NPRS > 0 Then
      frmHSMInput.tblStress.Rows = NPRS
      ReDim arySTR(NPRS, 7)
      For i = 1 To NPRS
         Line Input #filenumber, buffer
         Call StressLines(buffer, i)
      Next i
      frmHSMInput.tblStress.Refresh
   Else
      frmHSMInput.tblStress.Rows = NPRS
      frmHSMInput.tblStress.Refresh
   End If

   'line 11 - Complete Output Picture Lines
   If NPIC > 0 Then
      frmHSMInput.tblPicLines.Rows = NPIC
      ReDim aryPIC(NPIC, 2)
```

```
      For i = 1 To NPIC
         Line Input #filenumber, buffer
         Call PictureLines(buffer, i)
      Next i
      frmHSMInput.tblPicLines.Refresh
   Else
      frmHSMInput.tblPicLines.Rows = NPIC
      frmHSMInput.tblPicLines.Refresh
   End If

   'line 8A & 8B - Deformation Amplification Factor
   If NANG > 0 Then
      For i = 1 To NANG + 1
         Line Input #filenumber, buffer
         'Call PlotInfo(buffer, i)
      Next i
   End If

   'line 12 - ICIF Data Lines
   Line Input #filenumber, buffer
   NPTS = Val(Mid$(buffer, 1, 5))
   If Mid$(buffer, 11, 10) <> Space(10) Then
      F1 = CDbl(Mid$(buffer, 11, 10
   End If
   If Mid$(buffer, 11, 10) <> Space(10) Then
      F2 = CDbl(Mid$(buffer, 21, 10
   End If
   frmHSMInput.txtF1 = Mid$(buffer, 11, 10)
   frmHSMInput.txtF2 = Mid$(buffer, 21, 10)
   frmHSMInput.tblFuncSpec.Rows = NPTS
   ReDim aryFSL(NPTS, 3)
   For i = 1 To NPTS
      Line Input #filenumber, buffer
      Call ICIF(buffer, i)
   Next i
   frmHSMInput.tblFuncSpec.Refresh

   'line 13 - Plane Identification Line
   ReDim aryNOP(KONTRL(4), 27)
   If KONTRL(4) <> 0 Then
      frmHSMInput.tblPlaneLines.Rows = KONTRL(4)
      For i = 1 To KONTRL(4)
         Call PlaneID(filenumber, buffer, i)
      Next i
      frmHSMInput.tblPlaneLines.Refresh
   Else
      frmHSMInput.tblPlaneLines.Rows = KONTRL(4)
      frmHSMInput.tblPlaneLines.Refresh
   End If

   'line 14 - Spinal Injury Function Lines
   If Not EOF(filenumber) Then
      Call SpinalInjury(filenumber, buffer)
   Else
      frmHSMInput.txtFACT.Text = ""
      frmHSMInput.txtNSTART.Text = ""
      frmHSMInput.txtISYM.Text = ""
      frmHSMInput.tblSpine.Rows = 0
      frmHSMInput.tblSpine.Refresh
   End If

   'line 15 - Deformation Configuration Plot Lines
   If Not EOF(filenumber) Then
      Call PlotLines(filenumber, buffer)
   Else
      frmHSMInput.txtPLTDCD.Text = ""
      frmHSMInput.txtPLTLAB.Text = ""
      frmHSMInput.txtIOPTPLT.Text = ""
      frmHSMInput.txtTitle2.Text = ""
      frmHSMInput.txtxmin.Text = ""
      frmHSMInput.txtxmax.Text = ""
      frmHSMInput.txtymin.Text = ""
      frmHSMInput.txtymax.Text = ""
      frmHSMInput.txtzmin.Text = ""
      frmHSMInput.txtzmax.Text = ""
      frmHSMInput.txtTotalx.Text = ""
      frmHSMInput.txtTotaly.Text = ""
```

```
      frmHSMInput.txtTotalz.Text = ""
      frmHSMInput.txtxneg.Text = ""
      frmHSMInput.txtyneg.Text = ""
      frmHSMInput.txtzneg.Text = ""
      frmHSMInput.txtCommand.Text = ""
   End If

   Close #filenumber
   Exit Sub

ErrorHandlerO:
   If Err = 62 Then Exit Sub
   Resume Next
```

End Sub

Sub SpinalInjury (filenumber, buffer)

```
   'This routine reads spinal injury lines and extracts the field values

   Dim i As Integer       'counter
   Dim j As Integer       'counter
   Dim k As Integer       'counter

   'line 14A
   Line Input #filenumber, buffer
   JSTART = Val(Mid$(buffer, 1, 10))     ' bottommost vertebral level
   JEND = Val(Mid$(buffer, 11, 10))      ' uppermost vertebral level
   NB = JEND - JSTART
   frmHSMInput.tblSpine.Rows = NB
   ReDim arySPN(NB, 4)
   For i = 1 To NB
      arySPN(i, 1) = Str$((JSTART - 1) + i)
   Next i

   'line 14B - Axial Compression
   j = 0
   k = 0
   Do While k < NB
      Line Input #filenumber, buffer
      For i = 1 To 16
         arySPN(i + j, 2) = Mid$(buffer, (i * 5) - 4, 5)
         k = i + j
         If k = NB Then Exit For
      Next i
      j = k
   Loop

   'line 14C - Lateral Bending Moment
   j = 0
   k = 0
   Do While k < NB
      Line Input #filenumber, buffer
      For i = 1 To 16
         arySPN(i + j, 3) = Mid$(buffer, (i * 5) - 4, 5)
         k = i + j
         If k = NB Then Exit For
      Next i
      j = k
   Loop

   'line 14D - Anterior-posterior Bending Moment
   j = 0
   k = 0
   Do While k < NB
      Line Input #filenumber, buffer
      For i = 1 To 16
         arySPN(i + j, 4) = Mid$(buffer, (i * 5) - 4, 5)
         k = i + j
         If k = NB Then Exit For
      Next i
      j = k
   Loop

   'line 14E - Exponential factor and symmetry
```

```
    Line Input #filenumber, buffer
    frmHSMInput.txtFACT.Text = Mid$(buffer, 1, 10)
    frmHSMInput.txtNSTART.Text = Mid$(buffer, 11, 5)
    frmHSMInput.txtISYM.Text = Mid$(buffer, 16, 5)
```

End Sub

Sub StressLines (buffer, i)

```
    'This routine extracts fields from a stress output line

    arySTR(i, 1) = Mid$(buffer, 1, 5)       ' element number
    arySTR(i, 2) = Mid$(buffer, 6, 1)       ' I1
    arySTR(i, 3) = Mid$(buffer, 7, 1)       ' I2
    arySTR(i, 4) = Mid$(buffer, 8, 1)       ' I3
    arySTR(i, 5) = Mid$(buffer, 9, 1)       ' M
    arySTR(i, 6) = Mid$(buffer, 10, 1)      ' N
    arySTR(i, 7) = Mid$(buffer, 21, 40)     ' label
```

End Sub

Sub Vectors (buffer, i)

```
    'This routine extracts fields from the X-Bar and Y-Bar Vector lines

    aryVEC(i, 1) = Mid$(buffer, 1, 5)       ' node number
    aryVEC(i, 2) = Mid$(buffer, 5, 5)       ' space
    aryVEC(i, 3) = Mid$(buffer, 11, 10)     ' EULCO(1,1)
    aryVEC(i, 4) = Mid$(buffer, 21, 10)     ' EULCO(2,1)
    aryVEC(i, 5) = Mid$(buffer, 31, 10)     ' EULCO(3,1)
    aryVEC(i, 6) = Mid$(buffer, 41, 10)     ' EULCO(1,2)
    aryVEC(i, 7) = Mid$(buffer, 51, 10)     ' EULCO(2,2)
    aryVEC(i, 8) = Mid$(buffer, 61, 10)     ' EULCO(3,2)
```

End Sub

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```
Option Explicit
```

Function ControlOut (buffer) As String

```
   'This function sets the control line buffer based
   'on the values on the input screen.

   Dim i As Integer          'counter
   Dim temp As Integer       'temporary variable

   ' global or local coordinate option for secondary nodes
   If frmHSMInput.optKONTRL1(0).Value = True Then
      Mid$(buffer, 1, 5) = "    0"
   Else
      Mid$(buffer, 1, 5) = "    1"
   End If

   ' print option
   If frmHSMInput.chkKONTRL2.Value = True Then
      Mid$(buffer, 6, 5) = "    0"
   Else
      Mid$(buffer, 6, 5) = "    1"
   End If

   ' control parameter for initial body axes
   For i = 0 To 2
      If frmHSMInput.optKONTRL3(i).Value = True Then
         Mid$(buffer, 11, 5) = "    " & Str$(i)
      End If
   Next i

   ' number of sliding interface planes
   Mid$(buffer, 16, 5) = FormatNum(Val(frmHSMInput.txtKONTRL4.Text), 5)
   ' beta parameter in the Newmark integration
   Mid$(buffer, 21, 5) = FormatNum(Val(frmHSMInput.txtKONTRL5.Text), 5)
   ' number of secondary bodies for contact
   Mid$(buffer, 26, 5) = FormatNum(Val(frmHSMInput.txtKONTRL6.Text), 5)

   ' default node type
   If frmHSMInput.optKONTRL7(0).Value = True Then
      Mid$(buffer, 31, 5) = "    0"
   Else
      Mid$(buffer, 31, 5) = "    1"
   End If

   ' critical or viscous damping
   If frmHSMInput.optKONTRL8(0).Value = True Then
      Mid$(buffer, 36, 5) = "    0"
   Else
      Mid$(buffer, 36, 5) = "    1"
   End If

   ' type of integration
   If frmHSMInput.optKONTRL9(0).Value = True Then
      Mid$(buffer, 41, 5) = "    0"
   Else
      Mid$(buffer, 41, 5) = "    1"
   End If

   ' restart control
   Mid$(buffer, 46, 5) = Format$(frmHSMInput.txtKONTRL10.Text, "#####")

   ' Q array output?
   For i = 0 To 2
      If frmHSMInput.optKONTRL11(i).Value = True Then
         Mid$(buffer, 51, 5) = "    " & Str$(i)
      End If
   Next i

   ' triangle place element
   If frmHSMInput.optKONTRL12(0).Value = True Then
```

```
      Mid$(buffer, 56, 5) = "    0"
   Else
      Mid$(buffer, 56, 5) = "    1"
   End If

   ' logical unit option
   Mid$(buffer, 61, 5) = "    1"

   ' contact with seat back?
   If frmHSMInput.optKONTRL14(0).Value = True Then
      Mid$(buffer, 66, 5) = "    0"
   Else
      Mid$(buffer, 66, 5) = "    1"
   End If

   ' injury potential determined?
   If frmHSMInput.optKONTRL15(0).Value = True Then
      Mid$(buffer, 71, 5) = "    0"
   Else
      Mid$(buffer, 71, 5) = "    1"
   End If

   '  preejection pilot alignment simulation?
   If frmHSMInput.optKONTRL16(0).Value = True Then
      Mid$(buffer, 76, 5) = "    0"
   Else
      Mid$(buffer, 76, 5) = "    1"
   End If
   ControlOut = buffer

End Function

Sub CrossOut (filenumber, buffer)

   'This routine builds the buffer and writes cross sectional geometries
   'lines to the input file.

   Dim i As Integer      'counter

   Mid$(buffer, 1, 5) = FormatNum(NUMSEC, 5)
   Print #filenumber, buffer
   buffer = Space(80)
   If NUMSEC <> 0 Then
      If NUMSEC < 16 Then
         For i = 1 To NUMSEC
            Mid$(buffer, (i - 1) * 5 + 1, 5) = aryIPT(i)
         Next i
         Print #filenumber, buffer
         buffer = Space(80)
      End If
   End If

End Sub

Sub DisplaceOut (filenumber, buffer)

   'This routine builds the buffer and writes displacement
   'lines to the input file.

   Dim i As Integer      'counter

   For i = 1 To NUMDIS
      Mid$(buffer, 1, 4) = aryDIS(i, 1)     ' node number
      Mid$(buffer, 5, 1) = aryDIS(i, 2)     ' translational x
      Mid$(buffer, 6, 1) = aryDIS(i, 3)     ' translational y
      Mid$(buffer, 7, 1) = aryDIS(i, 4)     ' translational z
      Mid$(buffer, 8, 1) = aryDIS(i, 5)     ' rotation x
      Mid$(buffer, 9, 1) = aryDIS(i, 6)     ' rotation y
      Mid$(buffer, 10, 1) = aryDIS(i, 7)    ' rotation z
      Print #filenumber, buffer
      buffer = Space(80)
   Next i

End Sub
```

Sub ElementOut (filenumber, buffer)

```
'This routine builds the buffer and writes element
'lines to the input file.

Dim i As Integer      'counter

For i = 1 To NELE
   Mid$(buffer, 1, 5) = aryELE(i, 1)       ' node number
   Mid$(buffer, 6, 5) = aryELE(i, 2)       ' Node I
   Mid$(buffer, 11, 5) = aryELE(i, 3)      ' Node J
   Mid$(buffer, 16, 5) = aryELE(i, 4)      ' primary node for I
   Mid$(buffer, 21, 5) = aryELE(i, 5)      ' primary node for J
   Mid$(buffer, 26, 5) = aryELE(i, 6)      ' not used
   Mid$(buffer, 31, 5) = aryELE(i, 7)      ' not used
   Mid$(buffer, 36, 5) = aryELE(i, 8)      ' not used
   Mid$(buffer, 41, 5) = aryELE(i, 9)      ' Node K
   Mid$(buffer, 46, 5) = aryELE(i, 10)     ' material type
   Mid$(buffer, 51, 5) = aryELE(i, 11)     ' element type
   Mid$(buffer, 56, 5) = aryELE(i, 12)     ' not used
   Mid$(buffer, 61, 5) = aryELE(i, 13)     ' number of sliding node pairs
   Mid$(buffer, 66, 5) = aryELE(i, 14)     ' not used
   Mid$(buffer, 71, 5) = aryELE(i, 15)     ' not used
   Mid$(buffer, 76, 5) = aryELE(i, 16)     ' level
   Print #filenumber, buffer
   buffer = Space(80)
Next i
```

End Sub

Sub ICIFOut (filenumber, buffer)

```
'This routine builds the buffer and writes ICIF
'lines to the input file.

Dim i As Integer      'counter

Mid$(buffer, 1, 5) = FormatNum(NPTS, 5)
Mid$(buffer, 6, 5) = Space(5)
Mid$(buffer, 11, 10) = frmHSMInput.txtF1.Text
Mid$(buffer, 21, 10) = frmHSMInput.txtF2.Text
Print #filenumber, buffer
buffer = Space(80)
For i = 1 To NPTS
   Mid$(buffer, 1, 10) = aryFSL(i, 1)      ' Time t
   Mid$(buffer, 11, 10) = aryFSL(i, 2)     ' motion function value at time t
   Mid$(buffer, 21, 10) = aryFSL(i, 3)     ' derivative of function at time t
   Print #filenumber, buffer
   buffer = Space(80)
Next i
```

End Sub

Sub MaterialOut (filenumber, buffer)

```
'This routine builds the buffer and writes material properties
'lines to the input file.

Dim i As Integer      'counter

' line 4 - Material Property Lines
For i = 1 To NUMMAT
   Mid$(buffer, 1, 5) = aryMAT(i, 1)       ' MTYP
   Mid$(buffer, 6, 5) = aryMAT(i, 2)       ' LTYP
   Print #filenumber, buffer
   buffer = Space(80)
   Mid$(buffer, 1, 10) = aryMAT(i, 3)      ' E(1,MTYP)
   Mid$(buffer, 11, 10) = aryMAT(i, 4)     ' E(2,MTYP)
   Mid$(buffer, 21, 10) = aryMAT(i, 5)     ' E(3,MTYP)
   Mid$(buffer, 31, 10) = aryMAT(i, 6)     ' E(4,MTYP)
   Mid$(buffer, 41, 10) = aryMAT(i, 7)     ' E(5,MTYP)
   Mid$(buffer, 51, 10) = aryMAT(i, 8)
```

```
' E(6,MTYP)
        Print #filenumber, buffer
        buffer = Space(80)
        Mid$(buffer, 1, 10) = aryMAT(i, 9)        ' E(7,MTYP)
        Mid$(buffer, 11, 10) = aryMAT(i, 10)      ' E(8,MTYP)
        Mid$(buffer, 21, 10) = aryMAT(i, 11)      ' E(9,MTYP)
        Mid$(buffer, 31, 10) = aryMAT(i, 12)      ' E(10,MTYP)
        Mid$(buffer, 41, 10) = aryMAT(i, 13)      ' E(11,MTYP)
        Mid$(buffer, 51, 10) = aryMAT(i, 14)      ' E(12,MTYP)
        Print #filenumber, buffer
        buffer = Space(80)
    Next i

End Sub

Sub MotionOut (filenumber, buffer)

    'This routine builds the buffer and writes motion
    'lines to the input file.

    Dim i As Integer

    If NPRU > 0 Then
       For i = 1 To NPRU
          Mid$(buffer, 1, 7) = aryMOT(i, 1)      ' node number
          Mid$(buffer, 8, 1) = aryMOT(i, 2)      ' component number of kinematic variable to be output
          Mid$(buffer, 9, 1) = aryMOT(i, 3)      ' displacement, velocity, or acceleration (0,1,2)
          Mid$(buffer, 10, 1) = aryMOT(i, 4)     ' plot control (0-4)
          Mid$(buffer, 21, 40) = aryMOT(i, 5)    ' label
          Print #filenumber, buffer
          buffer = Space(80)
       Next i
    End If

End Sub

Sub NodeOut (filenumber, buffer)

    'This routine builds the buffer and writes node
    'lines to the input file.

    Dim i As Integer       'counter

    For i = 1 To NNODE + NAXOR
       Mid$(buffer, 1, 5) = aryNOD(i, 1)        ' node number
       Mid$(buffer, 6, 1) = aryNOD(i, 2)        ' coordinate type
       Mid$(buffer, 7, 1) = aryNOD(i, 3)        ' generation level
       Mid$(buffer, 10, 1) = aryNOD(i, 4)       ' Secondary/Primary
       Mid$(buffer, 11, 10) = aryNOD(i, 5)      ' x coordinate
       Mid$(buffer, 21, 10) = aryNOD(i, 6)      ' y coordinate
       Mid$(buffer, 31, 10) = aryNOD(i, 7)      ' z coordinate
       Mid$(buffer, 41, 10) = aryNOD(i, 8)      ' TMASS(1)
       Mid$(buffer, 51, 10) = aryNOD(i, 9)      ' TMASS(2)
       Mid$(buffer, 61, 10) = aryNOD(i, 10)     ' TMASS(3)
       Mid$(buffer, 71, 10) = aryNOD(i, 11)     ' TMASS(4)
       Print #filenumber, buffer
       buffer = Space(80)
    Next i

End Sub

Function OutputOut (buffer) As String

    'This routine builds the buffer and writes the output
    'line to the input file.

    ' frequency of output
    Mid$(buffer, 1, 5) = frmHSMInput.txtNPFREQ
    ' number of motion output lines
    Mid$(buffer, 6, 5) = frmHSMInput.txtNPRU
    ' number of stress output lines
    Mid$(buffer, 11, 5) = frmHSMInput.txtNPRS
```

```
' number of complete output pictures
   Mid$(buffer, 16, 5) = frmHSMInput.txtNPIC
   ' used when ELMPLT is desired in output
   Mid$(buffer, 21, 5) = frmHSMInput.txtNANG
   ' primary node for printer plots
   Mid$(buffer, 26, 5) = frmHSMInput.txtNDREF
   OutputOut = buffer

End Function

Function ParameterOut (buffer) As String

   'This routine builds the buffer and writes the parameter
   'line to the input file.

     ' number of nodes in the model
   Mid$(buffer, 1, 5) = frmHSMInput.txtNNODE
     ' number of primary nodes in the model
   Mid$(buffer, 6, 5) = frmHSMInput.txtNPRI
     ' number of axis orientation modes in the model
   Mid$(buffer, 11, 5) = frmHSMInput.txtNAXOR
     ' number of elements in the model
   Mid$(buffer, 16, 5) = frmHSMInput.txtNELE
     ' number of different element section and material types
   Mid$(buffer, 21, 5) = frmHSMInput.txtNUMMAT
     ' number of nodes at which any displacement components are specified
   Mid$(buffer, 26, 5) = frmHSMInput.txtNUMDIS
     ' number of time steps to be taken
   Mid$(buffer, 31, 6) = frmHSMInput.txtMXSTEP
     ' number of degrees of freedom per node
   Mid$(buffer, 37, 4) = frmHSMInput.txtNDGREE
     ' time increment
   Mid$(buffer, 41, 10) = frmHSMInput.txtDELT
     ' largest node number in model
   Mid$(buffer, 51, 5) = frmHSMInput.txtNODMAX
   ParameterOut = buffer

End Function

Sub PictureOut (filenumber, buffer)

   'This routine builds the buffer and writes picture
   'lines to the input file.

   Dim i As Integer      'counter

   If NPIC > 0 Then
      For i = 1 To NPIC
         Mid$(buffer, 1, 10) = aryPIC(i, 1)  ' time step at which complete output picture is desired
         Mid$(buffer, 11, 10) = aryPIC(i, 2) ' KON (0-6)
         Print #filenumber, buffer
         buffer = Space(80)
      Next i
   End If

End Sub

Sub PlaneOut (filenumber, buffer)

   'This routine builds the buffer and writes plane identification
   'lines to the input file.

   Dim i As Integer      'counter
   Dim j As Integer      'counter

   For i = 1 To KONTRL(4)
    ' line 13 - Plane Identification Line
      Mid$(buffer, 1, 5) = aryNOP(i, 1)          ' primary node number designating the plane
      Mid$(buffer, 6, 5) = aryNOP(i, 2)          ' total number of primary nodes of the model which may
»» contact plane I
      Mid$(buffer, 11, 10) = aryNOP(i, 3)        ' direction cosine of acceleration vector with respect
»» to the global x-axis
      Mid$(buffer, 21, 10) = aryNOP(i, 4)
```

```
' direction cosine of acceleration vector with respect
»» to the global y-axis
      Mid$(buffer, 31, 10) = aryNOP(i, 5)      ' direction cosine of acceleration vector with respect
»» to the global z-axis
      Mid$(buffer, 41, 10) = aryNOP(i, 6)      ' linear stiffness of elastic plane I
      Mid$(buffer, 51, 10) = aryNOP(i, 7)      ' cubic stiffness of elastic plane I
      Mid$(buffer, 61, 10) = aryNOP(i, 8)      ' fraction of viscous damping for plane I
      Print #filenumber, buffer
      buffer = Space(80)
    ' line 13A - Contacting Primary Node Numbers Line
      If Val(aryNOP(i, 2)) > 0 Then
         For j = 1 To Val(aryNOP(i, 2))
            Mid$(buffer, (j - 1) * 5 + 1, 5) = aryNOP(i, 8 + j)
         Next j
      Else
         Mid$(buffer, 1, 5) = aryNOP(i, 9)
         Mid$(buffer, 6, 5) = aryNOP(i, 10)
      End If
      Print #filenumber, buffer
      buffer = Space(80)
      Mid$(buffer, 1, 10) = aryNOP(i, 19)
      Mid$(buffer, 11, 10) = aryNOP(i, 20)
      Mid$(buffer, 21, 10) = aryNOP(i, 21)
      Print #filenumber, buffer
      buffer = Space(80)
      Mid$(buffer, 1, 10) = aryNOP(i, 22)
      Mid$(buffer, 11, 10) = aryNOP(i, 23)
      Mid$(buffer, 21, 10) = aryNOP(i, 24)
      Print #filenumber, buffer
      buffer = Space(80)
      Mid$(buffer, 1, 10) = aryNOP(i, 25)
      Mid$(buffer, 11, 10) = aryNOP(i, 26)
      Mid$(buffer, 21, 10) = aryNOP(i, 27)
      Print #filenumber, buffer
      buffer = Space(80)
      If KONTRL(14) = 1 Then
         'Line Input #filenumber, buffer
      End If
   Next i
```

End Sub

Sub PlotOut (filenumber, buffer)

```
   'This routine builds the buffer and writes plot
   'lines to the input file.

   Dim i As Integer       'counter

   If NANG > 0 Then
      For i = 1 To NANG + 1
         ' build buffer
         Print #filenumber, buffer
         buffer = Space(80)
      Next i
   End If
```

End Sub

Sub SaveInputFile ()

```
   'This routine displays a file selection dialog and saves the input file
   '  Subroutines called:  WriteInput
   '                       WriteOutput

   Dim buffer As String * 80      ' record buffer
   Dim filenumber As Integer      ' file handle

   frmHSMInput.dlgFile.Filter = " (*.inp) | *.inp "
   frmHSMInput.dlgFile.Action = 2
   If frmHSMInput.dlgFile.Filename <> "" Then
      filenumber = FreeFile
      Open frmHSMInput.dlgFile.Filename For Output Access Write As #filenumber Len = 80
      Call WriteInput(filenumber, buffer)
```

```
   Call WriteOutput(filenumber, buffer)
End If
Close #filenumber
Exit Sub
```

End Sub

Sub StressOut (filenumber, buffer)

```
'This routine builds the buffer and writes stress
'lines to the input file.

Dim i As Integer      'counter

If NPRS > 0 Then
   For i = 1 To NPRS
      Mid$(buffer, 1, 5) = arySTR(i, 1)     ' element number
      Mid$(buffer, 6, 1) = arySTR(i, 2)     ' I1
      Mid$(buffer, 7, 1) = arySTR(i, 3)     ' I2
      Mid$(buffer, 8, 1) = arySTR(i, 4)     ' I3
      Mid$(buffer, 9, 1) = arySTR(i, 5)     ' M
      Mid$(buffer, 10, 1) = arySTR(i, 6)    ' N
      Mid$(buffer, 21, 40) = arySTR(i, 7)   ' label
      Print #filenumber, buffer
      buffer = Space(80)
   Next i
End If
```

End Sub

Sub VectorOut (filenumber, buffer)

```
'This routine builds the buffer and writes vector
'lines to the input file.

Dim i As Integer      'counter

For i = 1 To NPRI
   Mid$(buffer, 1, 5) = aryVEC(i, 1)        ' node number
   Mid$(buffer, 5, 5) = aryVEC(i, 2)        ' space
   Mid$(buffer, 11, 10) = aryVEC(i, 3)      ' EULCO(1,1)
   Mid$(buffer, 21, 10) = aryVEC(i, 4)      ' EULCO(2,1)
   Mid$(buffer, 31, 10) = aryVEC(i, 5)      ' EULCO(3,1)
   Mid$(buffer, 41, 10) = aryVEC(i, 6)      ' EULCO(1,2)
   Mid$(buffer, 51, 10) = aryVEC(i, 7)      ' EULCO(2,2)
   Mid$(buffer, 61, 10) = aryVEC(i, 8)      ' EULCO(3,2)
   Print #filenumber, buffer
   buffer = Space(80)
Next i
```

End Sub

Sub WriteInput (filenumber, buffer)

```
'This routine calls routines which write the input data to the
'input file.
'  Subroutines called:  ParameterOut
'                       ControlOut
'                       MaterialOut
'                       NodeOut
'                       ElementOut
'                       DisplaceOut
'                       CrossOut
'                       VectorOut

Dim i As Integer      'counter

' line 1 - TITLE
buffer = frmHSMInput.txtTITLE
Print #filenumber, buffer
buffer = Space(80)
' line 2 - Paramenter Line
```

```
buffer = ParameterOut(buffer)
Print #filenumber, buffer
buffer = Space(80)
' line 3 - Program Control Line
buffer = ControlOut(buffer)
Print #filenumber, buffer
buffer = Space(80)

' line 4 - Material Property Lines
Call MaterialOut(filenumber, buffer)
' line 5 - Nodal Data Lines
Call NodeOut(filenumber, buffer)
' line 6 - Element Data Lines
Call ElementOut(filenumber, buffer)
' line 7 - Prescribed Displacement Lines
Call DisplaceOut(filenumber, buffer)

'line 7B & 7C - Cross-Sectional Geometries Code
If KONTRL(9) <> 0 Then
   Call CrossOut(filenumber, buffer
End If

'line 7D & 7E - X-Bar, Y-Bar Vectors
If KONTRL(3) = 2 Then
   Call VectorOut(filenumber, buffer
End If

'line 7F
If NLOAD <> 0 Then
   Mid$(buffer, 1, 5) = FormatNum(NLOAD, 5)
   Mid$(buffer, 6, 5) = FormatNum(NIC, 5)
   Print #filenumber, buffer
Else
   Print #filenumber,
End If
```

End Sub

Sub WriteOutput (filenumber, buffer)

```
'This routine calls routines which write the output specifications to the
'input file.
'  Subroutines called:  MotionOut
'                       StressOut
'                       PictureOut
'                       PlotOut
'                       ICIFOut
'                       PlaneOut
'                       CrossOut
'                       VectorOut

'line 8 - Output Control Line
buffer = OutputOut(buffer)
Print #filenumber, buffer
buffer = Space(80)

'line 9 - Motion Output Lines
Call MotionOut(filenumber, buffer)

'line 10 - Stress Output Lines
Call StressOut(filenumber, buffer)

'line 11 - Complete Output Picture Lines
Call PictureOut(filenumber, buffer)

'line 8A & 8B - Deformation Amplification Factor
Call PlotOut(filenumber, buffer)

'line 12 - ICIF Data Lines
Call ICIFOut(filenumber, buffer)

'line 13 - Plane Identification Line
If KONTRL(4) <> 0 Then
   Call PlaneOut(filenumber, buffer)
End If
```

```
'line 14 - Spinal Injury Function Lines
'If Not EOF(filenumber) Then
'   Call SpinalInjury(filenumber, buffer)
'Else
'   frmHSMInput.txtFACT.Text = ""
'   frmHSMInput.txtNSTART.Text = ""
'   frmHSMInput.txtISYM.Text = ""
'   frmHSMInput.tblSpine.Rows = 0
'   frmHSMInput.tblSpine.Refresh
'End If

'line 15 - Deformation Configuration Plot Lines
'If Not EOF(filenumber) Then
'   Call PlotLines(filenumber, buffer)
'Else
'   frmHSMInput.txtPLTDCD.Text = ""
'   frmHSMInput.txtPLTLAB.Text = ""
'   frmHSMInput.txtIOPTPLT.Text = ""
'   frmHSMInput.txtTitle2.Text = ""
'   frmHSMInput.txtxmin.Text = ""
'   frmHSMInput.txtxmax.Text = ""
'   frmHSMInput.txtymin.Text = ""
'   frmHSMInput.txtymax.Text = ""
'   frmHSMInput.txtzmin.Text = ""
'   frmHSMInput.txtzmax.Text = ""
'   frmHSMInput.txtTotalx.Text = ""
'   frmHSMInput.txtTotaly.Text = ""
'   frmHSMInput.txtTotalz.Text = ""
'   frmHSMInput.txtxneg.Text = ""
'   frmHSMInput.txtyneg.Text = ""
'   frmHSMInput.txtzneg.Text = ""
'   frmHSMInput.txtCommand.Text = ""
'End If

  Exit Sub

End Sub
```

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```
Option Explicit

Global Plotval() As Double      'array of plot data
Global ttitles() As String      'array of plot titles
```

Function ConvD (str1)

```
    'function to convert a string to a double precision number
    '(handles exponential notation)

    Dim n As Integer            'position in string
    Dim expon As Integer        'exponent portion of string
    Dim frac As Double          'fractional portion of string
    Dim num As Double           'value to return

    n = InStr(1, str1, "D")
    If n <> 0 Then
       expon = Val(Mid$(str1, n + 1, 3))
       frac = Val(Mid$(str1, 1, n - 1))
       num = frac * 10 ^ expon
    Else
       num = Val(str1)
    End If
    ConvD = num
```

End Function

Sub PlotData (NPRU, numpts)

```
    'create data plots using Chart FX
    '  NPRU   = number of plots
    '  numpts = number of data points

    Dim i As Integer            'counter
    Dim j As Integer            'counter
    Dim tempmin As Double       'temporary variable for maximum data point
    Dim tempmax As Double       'temporary variable for minimum data point

    For j = 1 To NPRU
       tempmin = Plotval(1, j + 1)
       tempmax = Plotval(1, j + 1)
       'open communication channel to pass data
       frmPlot.Chart1.OpenData(COD_VALUES) = CHART_ML(1, 100)
       'setup axes and titles
       frmPlot.Chart1.ThisSerie = 0
       frmPlot.Chart1.SerLeg(0) = "Time"
       frmPlot.Chart1.LegStyle = CL_HIDEXLEG
       frmPlot.Chart1.FixedGap = 2
       frmPlot.Chart1.Title(CHART_TOPTIT) = ttitles(j)
       For i = 1 To numpts
          'pass data values
          frmPlot.Chart1.Value(i - 1) = Plotval(i, j + 1)
          If Plotval(i, j + 1) > tempmax Then tempmax = Plotval(i, j + 1)
          If Plotval(i, j + 1) < tempmin Then tempmin = Plotval(i, j + 1)
       Next i
       'setup axes minimums and maximums
       frmPlot.Chart1.Adm(CSA_MIN) = tempmin
       frmPlot.Chart1.Adm(CSA_MAX) = tempmax
       frmPlot.Chart1.Adm(CSA_XMAX) = numpts
       frmPlot.Chart1.CloseData(COD_VALUES) = 0
       'set command button caption
       If j < NPRU Then
          frmPlot.cmdClose.Caption = "Next"
       Else
          frmPlot.cmdClose.Caption = "Close"
       End If
       frmPlot.Show 1
    Next j
```

End Sub

Sub ReadData (filenumber, buffer)

```
    'read output file and store array values for plotting
    '  filenumber = file handle
    '  buffer     = buffer for file record
    '  subroutines called:  PlotData

    Dim accum As Double          'time counter
    Dim i As Integer             'counter
    Dim j As Integer             'counter
    Dim k As Integer             'counter
    Dim stepcount As Long        'step counter
    Dim numpts As Integer        'number of data points
    Dim MXSTEP As Integer        'maximum number of steps
    Dim NPFREQ As Integer        'output frequency
    Dim ICMND As Integer         'command line

    ' read title
    Line Input #filenumber, buffer

    ' read length of Q array
    Line Input #filenumber, buffer

    ' read parameters
    Line Input #filenumber, buffer   'number of nodes
       NNODE = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of primary nodes
       NPRI = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of axis orientation nodes
       NAXOR = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of elements
       NELE = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of materials
       NUMMAT = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of fixed nodes
       NUMDIS = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'number of increments
       MXSTEP = Val(Mid$(buffer, 43, 10))
    Line Input #filenumber, buffer   'degrees of freedom
    Line Input #filenumber, buffer   'time increment
       DELT = ConvD(Mid$(buffer, 43, 16))
    Line Input #filenumber, buffer   'maximum node number
    Line Input #filenumber, buffer   '2 blank lines
    Line Input #filenumber, buffer

    ' read controls
    Line Input #filenumber, buffer   'KONTRL(1)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(2)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(3)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(4)
       KONTRL(4) = Val(Mid$(buffer, 12, 5))
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(5)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(6)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(7)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(8)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(9)
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer
    Line Input #filenumber, buffer   'KONTRL(10)
    Line Input #filenumber, buffer   'KONTRL(11)
```

```
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'KONTRL(12)
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'KONTRL(13)
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'KONTRL(14)
   KONTRL(14) = Val(Mid$(buffer, 13, 5))
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'KONTRL(15)
   KONTRL(15) = Val(Mid$(buffer, 13, 5))
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'KONTRL(16)
Line Input #filenumber, buffer

'read materials (3 lines each)
For i = 1 To NUMMAT
   Line Input #filenumber, buffer
   Line Input #filenumber, buffer
   Line Input #filenumber, buffer
Next i

'read nodal data
Line Input #filenumber, buffer    '3 blank lines
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'nodal data header
Line Input #filenumber, buffer
For i = 1 To NNODE + NAXOR
   Line Input #filenumber, buffer
Next i

'read elements
Line Input #filenumber, buffer    'blank line
Line Input #filenumber, buffer    'element header
For i = 1 To NELE
   Line Input #filenumber, buffer
Next i

'read nodal data in different coordinates
Line Input #filenumber, buffer    '3 blank lines
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'nodal header
Line Input #filenumber, buffer
For i = 1 To NNODE
   Line Input #filenumber, buffer
Next i

'read displacement nodes
Line Input #filenumber, buffer    'displacement node header
Line Input #filenumber, buffer
For i = 1 To NUMDIS
   Line Input #filenumber, buffer
Next i

'read primary node mass array
Line Input #filenumber, buffer    'blank line
Line Input #filenumber, buffer    'header
Line Input #filenumber, buffer    'blank line
For i = 1 To NPRI
   Line Input #filenumber, buffer
Next i

'read total length of Q array after ASSBLE
Line Input #filenumber, buffer

'read output code
Line Input #filenumber, buffer    '2 blank lines
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'output header
Line Input #filenumber, buffer    'NPFREQ
   NPFREQ = Val(Mid$(buffer, 18, 10))
Line Input #filenumber, buffer    'NPRU
```

```
   NPRU = Val(Mid$(buffer, 18, 10))
Line Input #filenumber, buffer    'NPRS
   NPRS = Val(Mid$(buffer, 18, 10))
Line Input #filenumber, buffer    'NPIC
   NPIC = Val(Mid$(buffer, 18, 10))
Line Input #filenumber, buffer    'NANG
Line Input #filenumber, buffer    'NPSEC

'read nodal disp, vel, accel output
ReDim ttitles(NPRU)
Line Input #filenumber, buffer    'header
For i = 1 To NPRU
   Line Input #filenumber, buffer
   ttitles(i) = Mid$(buffer, 37, 40)
Next i

'read selective element stress array output
If NPRS > 0 Then
   Line Input #filenumber, buffer    'header
   For i = 1 To NPRS
      Line Input #filenumber, buffer
   Next i
End If

'read picture output
If NPIC > 0 Then
   ReDim NPOUT(NPIC)
   Line Input #filenumber, buffer    'header
   Line Input #filenumber, buffer
   For i = 1 To NPIC
      Line Input #filenumber, buffer    '2 blank lines
      Line Input #filenumber, buffer
      Line Input #filenumber, buffer
      NPOUT(i) = CLng(Mid$(buffer, 11, 7))
   Next i
End If

'read total length of Q array
Line Input #filenumber, buffer    'blank line
Line Input #filenumber, buffer

'read length of strs array
Line Input #filenumber, buffer    'blank line
Line Input #filenumber, buffer

'read numerical integration data
Line Input #filenumber, buffer    '4 blank lines
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'header
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'no. of points
   NPTS = Val(Mid$(buffer, 25, 5))
Line Input #filenumber, buffer    'initial velocity
Line Input #filenumber, buffer    'initial disp
Line Input #filenumber, buffer    'header
Line Input #filenumber, buffer
For i = 1 To NPTS
   Line Input #filenumber, buffer
   Line Input #filenumber, buffer    'blank line
Next i

'read plane information
If KONTRL(4) <> 0 Then
   For i = 1 To KONTRL(4)
      Line Input #filenumber, buffer    'blank line
      Line Input #filenumber, buffer    'plane line
      Line Input #filenumber, buffer    'direction cosines
      Line Input #filenumber, buffer    'line 2
      Line Input #filenumber, buffer    'seat back
      Line Input #filenumber, buffer    'associated space nodes
      Line Input #filenumber, buffer    'node numbers
      Line Input #filenumber, buffer    'x, y, z header
      Line Input #filenumber, buffer    'x1
      Line Input #filenumber, buffer
```

```
'x2
        Line Input #filenumber, buffer    'x3
        Line Input #filenumber, buffer    'header
        Line Input #filenumber, buffer    'nodes
    Next i
End If

'read nodes
If KONTRL(15) <> 0 Then
    Line Input #filenumber, buffer       'JSTART and JEND
        JSTART = Val(Mid$(buffer, 1, 10))
        JEND = Val(Mid$(buffer, 11, 10))
        NB = JEND - JSTART
    Line Input #filenumber, buffer       'SPINIF DATA header
    Line Input #filenumber, buffer       'Fact, Nstart
    Line Input #filenumber, buffer       'level header
    Line Input #filenumber, buffer       'blank line
    For i = 1 To NB
        Line Input #filenumber, buffer
    Next i
End If

'read original element lengths
Line Input #filenumber, buffer
Line Input #filenumber, buffer    'header
Line Input #filenumber, buffer
For i = 1 To NELE
    Line Input #filenumber, buffer
Next i

If NPIC > 0 Then
    Line Input #filenumber, buffer    'title
    Line Input #filenumber, buffer    'mins and maxs
    Line Input #filenumber, buffer    'totals
    ICMND = Val(Mid$(buffer, 62, 5))
    For i = 1 To ICMND
        Line Input #filenumber, buffer
    Next i
End If

'read output data
numpts = Int(MXSTEP / NPFREQ)
ReDim Plotval(numpts, NPRU + 1)
accum = 0
j = 0
For stepcount = 1 To MXSTEP
    accum = accum + DELT
    If NPIC > 0 Then
        For k = 1 To NPIC
            If stepcount = NPOUT(k) Then
                Line Input #filenumber, buffer    'punched cards
                Line Input #filenumber, buffer    'blank line
                Line Input #filenumber, buffer    'title
                Line Input #filenumber, buffer    'mins and maxs
                Line Input #filenumber, buffer    'totals
                For i = 1 To ICMND
                    Line Input #filenumber, buffer
                Next i
                For i = 1 To NB + 1
                    Line Input #filenumber, buffer    'plot lines
                Next i
                Line Input #filenumber, buffer        'GO line
            End If
        Next k
    End If
    If (stepcount Mod NPFREQ) = 0 Then
        j = j + 1
        If KONTRL(4) <> 0 Then
            Line Input #filenumber, buffer
        End If
        Line Input #filenumber, buffer
        If KONTRL(2) = 0 Then
            Plotval(j, 1) = accum
            If NPRU <= 6 Then
                Line Input #filenumber, buffer
                For k = 1 To NPRU
```

```
                Plotval(j, k + 1) = ConvD(Mid$(buffer, 26 + (k - 1) * 16, 16))
            Next k
         End If
      End If
   End If
Next stepcount

'complex output file format not addressed at this time
   'Line Input #filenumber, buffer    'spinal injury likelihood
   'Line Input #filenumber, buffer    'max compressive forces
   'Line Input #filenumber, buffer    'blank line
   'Line Input #filenumber, buffer    'p
   'Line Input #filenumber, buffer    'blank line
   'Line Input #filenumber, buffer    'bmy
   'Line Input #filenumber, buffer    'blank line
   'Line Input #filenumber, buffer    'bmz
   'Line Input #filenumber, buffer    'blank line
   'Line Input #filenumber, buffer    'tp,tmy,tmz
   'Line Input #filenumber, buffer    'blank line
   'Line Input #filenumber, buffer    'py,bmyy,bmzy
   'Line Input #filenumber, buffer    'level
   'Line Input #filenumber, buffer    'blank line
   'For i = 1 To NB
   '   Line Input #filenumber, buffer
   'Next i

'call plotting subroutine
Call PlotData(NPRU, numpts)
Close #filenumber
```

End Sub

Sub ReadOutFile ()

```
   'subroutine to read output file
   'standard output filename is "hsm.out"
   '  subroutines called:  ReadData

   Dim buffer As String * 80       'buffer for file record
   Dim filenumber As Integer       'file handle

   Outfile = App.Path & "\hsm.out"
   filenumber = FreeFile
   'open file
   Open Outfile For Input Access Read As #filenumber Len = 80
   On Error GoTo ErrorHandler2
   Call ReadData(filenumber, buffer)
   Close #filenumber
   Exit Sub

ErrorHandler2:
   If Err = 62 Then Exit Sub
   Resume Next
```

End Sub

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APPENDIX C

INVENTORY OF FILES

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<u>Archived HSM Files Presented at Kickoff</u>

```
total 5504
drwxr-xr-x   2 mike     user       5632 Aug 16 14:20 ./
drwxrwxrwx  17 root     sys        2560 Jul 21 21:46 ../
-rw-r--r--   1 jmartini user       6685 Oct  7  1993 ALPHAP.f
-rw-rw-r--   1 jmartini user      24244 Oct  7  1993 ALPHAP.o
-rw-r--r--   1 jmartini user       7251 Oct  7  1993 ASSBLE.f
-rw-rw-r--   1 jmartini user      18680 Oct  7  1993 ASSBLE.o
-rw-r--r--   1 jmartini user         62 Oct  7  1993 AXIS.f
-rw-rw-r--   1 jmartini user        684 Oct  7  1993 AXIS.o
-rw-r--r--   1 jmartini user       3333 Oct  7  1993 BASME.f
-rw-rw-r--   1 jmartini user       8792 Oct  7  1993 BASME.o
-rw-r--r--   1 jmartini user       8337 Oct  7  1993 BFRCIN.f
-rw-rw-r--   1 jmartini user      24372 Oct  7  1993 BFRCIN.o
-rw-r--r--   1 jmartini user         54 Oct  7  1993 CARCON.f
-rw-rw-r--   1 jmartini user        596 Oct  7  1993 CARCON.o
-rw-r--r--   1 jmartini user        706 Oct  7  1993 CROSS.f
-rw-rw-r--   1 jmartini user       2104 Oct  7  1993 CROSS.o
-rw-r--r--   1 jmartini user        478 Oct  7  1993 DECOD.f
-rw-rw-r--   1 jmartini user       1488 Oct  7  1993 DECOD.o
-rw-r--r--   1 jmartini user       2309 Oct  7  1993 EIGEN.f
-rw-rw-r--   1 jmartini user       8048 Oct  7  1993 EIGEN.o
-rw-r--r--   1 jmartini user         64 Oct  7  1993 ELMPLT.f
-rw-rw-r--   1 jmartini user        688 Oct  7  1993 ELMPLT.o
-rw-r--r--   1 jmartini user       4381 Oct  7  1993 ELOUT.f
-rw-rw-r--   1 jmartini user      13080 Oct  7  1993 ELOUT.o
-rw-r--r--   1 jmartini user       2970 Oct  7  1993 FRCIN.f
-rw-rw-r--   1 jmartini user       8184 Oct  7  1993 FRCIN.o
-rw-rw-r--   1 mike     user       1962 Aug  3 08:00 FREEFD.2
-rw-rw-r--   1 jmartini user       1952 Oct  7  1993 FREEFD.f
-rw-rw-r--   1 jmartini user       4588 Oct  7  1993 FREEFD.o
-rw-r--r--   1 mike     user       2876 Aug  3 08:00 FREEFD.old
-rw-r--r--   1 jmartini user         86 Oct  7  1993 GENFOR.f
-rw-rw-r--   1 jmartini user        840 Oct  7  1993 GENFOR.o
-rw-r--r--   1 jmartini user       1536 Oct  7  1993 GMPRD.f
-rw-rw-r--   1 jmartini user       2068 Oct  7  1993 GMPRD.o
-rw-r--r--   1 jmartini user       1516 Oct  7  1993 GTPRD.f
-rw-rw-r--   1 jmartini user       2028 Oct  7  1993 GTPRD.o
-rw-r--r--   1 jmartini user        955 Oct  7  1993 ICIF.f
-rw-rw-r--   1 jmartini user       4544 Oct  7  1993 ICIF.o
-rw-r--r--   1 jmartini user       1616 Oct  7  1993 ICIF2.f
-rw-rw-r--   1 jmartini user       5452 Oct  7  1993 ICIF2.o
-rw-r--r--   1 jmartini user        340 Oct  7  1993 INCODE.f
-rw-rw-r--   1 jmartini user       1052 Oct  7  1993 INCODE.o
-rw-r--r--   1 jmartini user         58 Oct  7  1993 LINE.f
-rw-rw-r--   1 jmartini user        656 Oct  7  1993 LINE.o
-rw-r--r--   1 jmartini user       7527 Oct  7  1993 LOCFRC.f
-rw-rw-r--   1 jmartini user      19664 Oct  7  1993 LOCFRC.o
-rw-r--r--   1 jmartini user         62 Oct  7  1993 LOFIX.f
-rw-rw-r--   1 jmartini user        600 Oct  7  1993 LOFIX.o
-rw-r--r--   1 jmartini user      11325 Oct  7  1993 OUTPUT.f
-rw-rw-r--   1 jmartini user      36696 Oct  7  1993 OUTPUT.o
-rw-r--r--   1 jmartini user         56 Oct  7  1993 PEGS.f
-rw-rw-r--   1 jmartini user        640 Oct  7  1993 PEGS.o
-rw-r--r--   1 jmartini user         53 Oct  7  1993 PLOT.f
```

```
-rw-rw-r--  1 jmartini user      612 Oct  7  1993 PLOT.o
-rw-r--r--  1 jmartini user     8161 Oct  7  1993 PLOTER.f
-rw-rw-r--  1 jmartini user    13156 Oct  7  1993 PLOTER.o
-rw-r--r--  1 jmartini user       54 Oct  7  1993 PLOTS.f
-rw-rw-r--  1 jmartini user      612 Oct  7  1993 PLOTS.o
-rw-r--r--  1 jmartini user       88 Oct  7  1993 PVFRCN.f
-rw-rw-r--  1 jmartini user      856 Oct  7  1993 PVFRCN.o
-rw-r--r--  1 jmartini user       72 Oct  7  1993 READFD.f
-rw-rw-r--  1 jmartini user      744 Oct  7  1993 READFD.o
-rw-r--r--  1 jmartini user    10852 Oct  7  1993 READIN.f
-rw-rw-r--  1 jmartini user    31860 Oct  7  1993 READIN.o
-rw-r--r--  1 jmartini user     3924 Oct  7  1993 READOU.f
-rw-rw-r--  1 jmartini user    13936 Oct  7  1993 READOU.o
-rw-r--r--  1 jmartini user       64 Oct  7  1993 READXS.f
-rw-rw-r--  1 jmartini user      688 Oct  7  1993 READXS.o
-rw-r--r--  1 jmartini user       47 Oct  7  1993 RELINE.f
-rw-rw-r--  1 jmartini user      564 Oct  7  1993 RELINE.o
-rw-r--r--  1 jmartini user       51 Oct  7  1993 RESTAR.f
-rw-rw-r--  1 jmartini user      580 Oct  7  1993 RESTAR.o
-rw-r--r--  1 jmartini user      847 Oct  7  1993 ROTATE.f
-rw-rw-r--  1 jmartini user     2292 Oct  7  1993 ROTATE.o
-rw-r--r--  1 jmartini user     2002 Oct  7  1993 ROTE.f
-rw-rw-r--  1 jmartini user     6516 Oct  7  1993 ROTE.o
-rw-r--r--  1 jmartini user       55 Oct  7  1993 SCALE.f
-rw-rw-r--  1 jmartini user      628 Oct  7  1993 SCALE.o
-rw-r--r--  1 jmartini user       86 Oct  7  1993 SECACC.f
-rw-rw-r--  1 jmartini user      840 Oct  7  1993 SECACC.o
-rw-r--r--  1 jmartini user     6136 Oct  7  1993 SFRCIN.f
-rw-rw-r--  1 jmartini user    16452 Oct  7  1993 SFRCIN.o
-rw-r--r--  1 jmartini user     6265 Oct  7  1993 SLIDER.f
-rw-rw-r--  1 jmartini user    20092 Oct  7  1993 SLIDER.o
-rw-r--r--  1 jmartini user    10317 Oct  7  1993 SOLVE.f
-rw-rw-r--  1 jmartini user    30808 Oct  7  1993 SOLVE.o
-rw-r--r--  1 jmartini user    13333 Oct  7  1993 SPINIF.f
-rw-rw-r--  1 jmartini user    36340 Oct  7  1993 SPINIF.o
-rw-r--r--  1 jmartini user       60 Oct  7  1993 SYMBOL.f
-rw-rw-r--  1 jmartini user      660 Oct  7  1993 SYMBOL.o
-rw-r--r--  1 jmartini user       77 Oct  7  1993 TASME.f
-rw-rw-r--  1 jmartini user      784 Oct  7  1993 TASME.o
-rw-r--r--  1 jmartini user       94 Oct  7  1993 TFRCIN.f
-rw-rw-r--  1 jmartini user      896 Oct  7  1993 TFRCIN.o
-rw-r--r--  1 jmartini user       67 Oct  7  1993 UASME.f
-rw-rw-r--  1 jmartini user      712 Oct  7  1993 UASME.o
-rw-r--r--  1 jmartini user       70 Oct  7  1993 UFRCIN.f
-rw-rw-r--  1 jmartini user      728 Oct  7  1993 UFRCIN.o
-rw-r--r--  1 jmartini user     6846 Oct  7  1993 UPDATE.f
-rw-rw-r--  1 jmartini user    10672 Oct  7  1993 UPDATE.o
-rw-r--r--  1 jmartini user      492 Oct  7  1993 VECT.f
-rw-rw-r--  1 jmartini user     1748 Oct  7  1993 VECT.o
-rw-r--r--  1 jmartini user     1371 Oct  7  1993 VECTOR.f
-rw-rw-r--  1 jmartini user     3576 Oct  7  1993 VECTOR.o
-rw-r--r--  1 jmartini user    15929 Oct  7  1993 WHAM3.f
-rw-rw-r--  1 jmartini user    34744 Oct  7  1993 WHAM3.o
-rw-r--r--  1 mike     user    30804 Aug  3 08:00 cr24b.inp
-rw-r--r--  1 mike     user   997025 Aug  3 07:59 cr24b.out
-rw-rw-r--  1 jmartini user     1467 Oct  7  1993 damp.
```

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-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 damp.new
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 damp.out
-rw-rw-r--   1 root     sys          0 Aug 16 14:20 dirhsm
-rw-r--r--   1 jmartini user      1357 Oct  7  1993 dumyhsm.f
-rw-rw-r--   1 jmartini user     13896 Oct  7  1993 fort.7
-rw-rw-r--   1 jmartini user      5150 Oct  7  1993 hb3flx.out
-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 hidamp.
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 hidamp.out
-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 histif.
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 histif.out
-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 hyb2.inp
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 hyb2.out
-rw-r--r--   1 jmartini user      1467 Oct  7  1993 hyb22.inp
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 hyb22.out
-rw-rw-r--   1 jmartini user      1798 Oct  7  1993 hyb3fdext.f
-rw-rw-r--   1 jmartini user      1794 Oct  7  1993 hyb3fdflx.f
-rw-rw-r--   1 jmartini user      1151 Oct  7  1993 hybIII.flex
-rw-rw-r--   1 jmartini user     24085 Oct  7  1993 hybIIIflx.out
-rw-rw-r--   1 jmartini user       544 Jul  7 21:42 info
-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 lostif.
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 lostif.out
-rw-r--r--   1 jmartini user       600 Oct  7  1993 makehsm
-rw-rw-r--   1 jmartini user      1467 Oct  7  1993 shear.
-rw-rw-r--   1 jmartini user     60804 Oct  7  1993 shear.out
-rw-rw-r--   1 jmartini user     44644 Oct  7  1993 shear2.out
-rwxrwxr-x   1 jmartini user    574404 Oct  7  1993 xhsm*
```

Archived Files in Directory HSM 001

```
total 106657
drwxr-xr-x   2 105     user     4096 Aug 16 14:18 ./
drwxrwxrwx  17 root    sys      2560 Jul 21 21:46 ../
-rw-rw-r--   1 105     user    53784 May 22  1986 ABEPLOT.FTN
-rw-rw-r--   1 105     user   124335 Aug  7  1986 ACES.FTN
-rw-rw-r--   1 105     user    60183 Sep  5  1986 ACES.INP
-rw-rw-r--   1 105     user  1163790 Sep  6  1986 ACES.OUT
-rw-rw-r--   1 105     user    60183 Aug  8  1986 ACES0.INP
-rw-rw-r--   1 105     user  1163790 Aug  8  1986 ACES0.OUT
-rw-rw-r--   1 105     user    60183 Aug  7  1986 ACES1.INP
-rw-rw-r--   1 105     user  1140474 Jun 22  1986 ACES1.OUT
-rw-rw-r--   1 105     user  1163790 Aug 12  1986 ACES2.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES2A.INP
-rw-rw-r--   1 105     user  1439428 Aug 22  1986 ACES2A.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES2B.INP
-rw-rw-r--   1 105     user  1439428 Aug 29  1986 ACES2B.OUT
-rw-rw-r--   1 105     user  1163790 Aug 13  1986 ACES3.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES3A.INP
-rw-rw-r--   1 105     user  1439428 Aug 25  1986 ACES3A.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES3B.INP
-rw-rw-r--   1 105     user  1439428 Sep  2  1986 ACES3B.OUT
-rw-rw-r--   1 105     user    60183 Aug 22  1986 ACES4.INP
-rw-rw-r--   1 105     user  1163790 Aug 13  1986 ACES4.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES4A.INP
-rw-rw-r--   1 105     user  1439428 Aug 25  1986 ACES4A.OUT
-rw-rw-r--   1 105     user    63423 Aug 22  1986 ACES4B.INP
-rw-rw-r--   1 105     user  1439428 Sep  4  1986 ACES4B.OUT
-rw-rw-r--   1 105     user    60183 Aug 22  1986 ACES5.INP
-rw-rw-r--   1 105     user  1163790 Aug 15  1986 ACES5.OUT
-rw-rw-r--   1 105     user    77760 Aug 19  1986 ACESA.FTN
-rw-rw-r--   1 105     user   162243 Apr 21  1986 ACESFD.FTN
-rw-rw-r--   1 105     user    20331 Jul 28  1986 ALPHAP.FTN
-rw-rw-r--   1 105     user      648 Aug 10  1987 BATCH.JEF
-rw-rw-r--   1 105     user      243 Aug  6  1987 BATCH.JJS
-rw-rw-r--   1 105     user    68931 May 17  1985 BOTJEFFD.FTN
-rw-rw-r--   1 105     user  1193940 Jul 24  1986 BUTT.OUT
-rw-rw-r--   1 105     user    50625 Oct  6  1986 CACESFD.FTN
-rw-rw-r--   1 105     user   233766 Aug 11  1986 CBEAM.FTN
-rw-rw-r--   1 105     user    17739 Jan  9  1987 CHECK.FTN
-rw-rw-r--   1 105     user    49977 May 16  1985 CILS.INP
-rw-rw-r--   1 105     user    87237 May 17  1985 CILSFD.FTN
-rw-rw-r--   1 105     user    89667 Sep 18  1986 CMODHARN.FTN
-rw-rw-r--   1 105     user      567 Aug  6  1987 COMBINE.CSS
-rw-rw-r--   1 105     user    16686 Sep  8  1986 COMBINE.FTN
-rw-rw-r--   1 105     user     6834 Aug  6  1987 COMBINE.OUT
-rw-rw-r--   1 105     user   496611 Dec 31  1986 COMBO.FTN
-rw-rw-r--   1 105     user    53460 Oct  6  1986 COMBOFD.FTN
-rw-rw-r--   1 105     user    17658 Jan 12  1987 COMILS.FTN
-rw-rw-r--   1 105     user      243 Oct 15  1986 COMP.CSS
-rw-rw-r--   1 105     user     2673 Apr 22  1986 DRIACES.INP
-rw-rw-r--   1 105     user     3483 Aug  7  1984 DRIVROD.FTN
-rw-rw-r--   1 105     user     3402 Jun  6  1985 EIGEN.FTN
-rw-rw-r--   1 105     user    11514 Jun 13  1987 F7CETRAP.CSS
-rw-rw-r--   1 105     user      162 Oct  6  1986 FAST.CSS
```

```
-rw-rw-r--  1 105  user    11097 Feb 28  1986 FDSSMCS.FTN
-rw-rw-r--  1 105  user    75978 May 23  1986 FHHENC.FTN
-rw-rw-r--  1 105  user     4293 Feb 27  1986 FIVEDOF.INP
-rw-rw-r--  1 105  user     3564 Apr 22  1986 FREEFDAC.FTN
-rw-rw-r--  1 105  user     5832 Feb 27  1986 FREEFDDO.FTN
-rw-rw-r--  1 105  user    15471 Jan  8  1987 FU.FTN
-rw-rw-r--  1 105  user      729 Jul 16  1986 GETIT.FTN
-rw-rw-r--  1 105  user    76545 Jun 25  1986 H7.FTN
-rw-rw-r--  1 105  user    59292 Jul  2  1986 H7.INP
-rw-rw-r--  1 105  user  1016390 Sep  6  1986 H7.OUT
-rw-rw-r--  1 105  user   122958 Sep  5  1986 H7A.FTN
-rw-rw-r--  1 105  user   124011 Sep 10  1986 HACESFD.FTN
-rw-rw-r--  1 105  user    39771 Feb 27  1986 HCS685.FTN
-rw-rw-r--  1 105  user   508113 May 16  1986 HCSCODE.FTN
-rw-rw-r--  1 105  user    59292 Aug  6  1987 HCSILS.INP
-rw-rw-r--  1 105  user  1254776 Aug 10  1987 HCSILS.OUT
-rw-rw-r--  1 105  user    12150 Aug 10  1987 HCSILS.PUN
-rw-rw-r--  1 105  user    91773 Jun 18  1986 HCSILSFD.FTN
-rw-rw-r--  1 105  user    96309 Aug  4  1987 HCSM.INP
-rw-rw-r--  1 105  user  2420442 Aug  6  1987 HCSM.OUT
-rw-rw-r--  1 105  user     2187 Aug  7  1987 HCSM.PUN
-rw-rw-r--  1 105  user   474984 Jun 24  1985 HCSMAR.FTN
-rw-rw-r--  1 105  user   472797 Jun 27  1985 HCSMARJ.FTN
-rw-rw-r--  1 105  user   472878 Feb 14  1986 HCSMARM.FTN
-rw-rw-r--  1 105  user   472878 Jan 28  1986 HCSMART.FTN
-rw-rw-r--  1 105  user   473445 May 20  1985 HCSMDLT.FTN
-rw-rw-r--  1 105  user   473931 Jun 11  1985 HCSMDTT.FTN
-rw-rw-r--  1 105  user   127656 Oct  1  1986 HCSMFD.FTN
-rw-rw-r--  1 105  user   548462 Aug  5  1987 HCSMFD.LST
-rw-rw-r--  1 105  user   465426 May 22  1985 HCSMRS2.FTN
-rw-rw-r--  1 105  user   465669 Jul 26  1985 HCSMRS3.FTN
-rw-rw-r--  1 105  user   479682 Apr 25  1985 HCSMRST.FTN
-rw-rw-r--  1 105  user   124416 Aug  7  1986 HHENC.FTN
-rw-rw-r--  1 105  user    60021 Aug  7  1986 HHENC.INP
-rw-rw-r--  1 105  user  1153874 Aug  8  1986 HHENC.OUT
-rw-rw-r--  1 105  user    60021 Aug  7  1986 HHENC1.INP
-rw-rw-r--  1 105  user  1153874 Jul 25  1986 HHENC1.OUT
-rw-rw-r--  1 105  user   124173 Jul 24  1986 HHENC2.FTN
-rw-rw-r--  1 105  user    60507 Jul 24  1986 HHENC2.INP
-rw-rw-r--  1 105  user  1200506 Jul 24  1986 HHENC2.OUT
-rw-rw-r--  1 105  user    49410 Aug  6  1987 HILS.INP
-rw-rw-r--  1 105  user    73953 May 14  1985 HILSFD.FTN
-rw-rw-r--  1 105  user    20331 Apr  5  1985 HSALPHAP.FTN
-rw-rw-r--  1 105  user   378351 Apr 24  1987 HSM.FTN
-rw-rw-r--  1 105  user    11988 Dec  5  1984 HSSSM.FTN
-rw-rw-r--  1 105  user   496611 Aug  4  1987 HTSM.FTN
-rw-rw-r--  1 105  user   151065 Aug  4  1987 HTSM.INP
-rw-rw-r--  1 105  user    77193 Aug  4  1987 HTSMFD.FTN
-rw-rw-r--  1 105  user   306860 Aug 10  1987 HTSMFD.LST
-rw-rw-r--  1 105  user    91287 Aug  4  1987 ILSFD.FTN
-rw-rw-r--  1 105  user   123280 Aug 10  1987 ILSFD.LST
-rw-rw-r--  1 105  user    59697 Jul 27  1987 ILSFRC.INP
-rw-rw-r--  1 105  user    60183 May 14  1987 ILSRET.INP
-rw-rw-r--  1 105  user   741824 May 15  1987 ILSRET.OUT
-rw-rw-r--  1 105  user    14256 May 15  1987 ILSRET.PUN
-rw-rw-r--  1 105  user     2592 Oct 22  1985 ITERATE.FTN
```

```
-rw-rw-r--  1 105  user  138510 Jan 21  1987 J.INP
-rw-rw-r--  1 105  user  567490 Jan 12  1987 J.OUT
-rw-rw-r--  1 105  user   60183 Aug 22  1986 JACES.INP
-rw-rw-r--  1 105  user 1203990 Sep  8  1986 JACES.OUT
-rw-rw-r--  1 105  user  124497 Jul 29  1986 JEF.FTN
-rw-rw-r--  1 105  user   30132 May 17  1985 JEFFFD.FTN
-rw-rw-r--  1 105  user   12231 May 22  1985 JSHCSSSM.INP
-rw-rw-r--  1 105  user   74277 May 16  1985 JSILSFD.FTN
-rw-rw-r--  1 105  user   12717 Jul 25  1986 JSSM.INP
-rw-rw-r--  1 105  user     648 Oct 17  1986 LIG.FTN
-rw-rw-r--  1 105  user    6318 Nov 30  1987 LINKHCS.CSS
-rw-rw-r--  1 105  user   20979 Jul  6  1984 LOCFRC.FTN
-rw-rw-r--  1 105  user  140940 Jan  9  1987 LONGB.INP
-rw-rw-r--  1 105  user       0 Jan  9  1987 LONGB.OUT
-rw-rw-r--  1 105  user    2268 Aug 21  1985 MULTIPLY.FTN
-rw-rw-r--  1 105  user     536 Jan  8  1987 MULTIPLY.OUT
-rw-rw-r--  1 105  user   46332 Apr 29  1985 NECKSSM.FTN
-rw-rw-r--  1 105  user   76626 May 24  1985 NKACBOT.FTN
-rw-rw-r--  1 105  user    1701 Feb 28  1986 ONEDOF.INP
-rw-rw-r--  1 105  user     810 Oct 15  1986 PLOTLIG.FTN
-rw-rw-r--  1 105  user    7938 Jul 22  1986 PLOTMULT.FTN
-rw-rw-r--  1 105  user    4455 Mar 27  1986 PLOTR.FTN
-rw-rw-r--  1 105  user    6075 Sep 12  1986 PLOTR2.FTN
-rw-rw-r--  1 105  user    8910 Nov 17  1986 PLOTSIF.FTN
-rw-rw-r--  1 105  user    5832 Jul  8  1985 PLOTTER.FTN
-rw-rw-r--  1 105  user    6642 Jun 19  1985 PLOTTER2.FTN
-rw-rw-r--  1 105  user   27540 Jul 24  1984 POLYFIT.FTN
-rw-rw-r--  1 105  user     567 Nov  5  1986 READIT.FTN
-rw-rw-r--  1 105  user   88452 Mar  6  1986 REC50FD.FTN
-rw-rw-r--  1 105  user   53460 Oct  6  1986 RESTARFD.FTN
-rw-rw-r--  1 105  user   24786 Mar 11  1987 RESTART.FTN
-rw-rw-r--  1 105  user     810 May 13  1987 RESTART.INP
-rw-rw-r--  1 105  user  109026 Aug 10  1987 RETRACT.FTN
-rw-rw-r--  1 105  user   50706 Aug 10  1987 RETRACT.INP
-rw-rw-r--  1 105  user    5994 Aug  7  1984 ROD.INP
-rw-rw-r--  1 105  user  494019 Oct  2  1986 RSSMCS.FTN
-rw-rw-r--  1 105  user    8829 Jul 15  1986 RUNFD.FTN
-rw-rw-r--  1 105  user    9639 Mar 22  1987 RUNHCS.CSS
-rw-rw-r--  1 105  user   10044 Apr 19  1985 RUNHCSA.CSS
-rw-rw-r--  1 105  user    9963 Jun 14  1987 RUNHCSAR.CSS
-rw-rw-r--  1 105  user   10044 Sep 18  1987 RUNHCSAT.CSS
-rw-rw-r--  1 105  user    9963 May 13  1987 RUNHCSCC.CSS
-rw-rw-r--  1 105  user   10125 Sep  3  1986 RUNHCSM.CSS
-rw-rw-r--  1 105  user    6561 Mar  4  1987 RUNHCSO.CSS
-rw-rw-r--  1 105  user    9963 Apr 24  1987 RUNHCSR.CSS
-rw-rw-r--  1 105  user    9963 May  8  1987 RUNHCSR2.CSS
-rw-rw-r--  1 105  user    9963 Oct 11  1985 RUNHCSR3.CSS
-rw-rw-r--  1 105  user   10125 Nov 17  1986 RUNHCSRJ.CSS
-rw-rw-r--  1 105  user    9963 May 20  1987 RUNHCST.CSS
-rw-rw-r--  1 105  user    9963 May 31  1987 RUNHCSTT.CSS
-rw-rw-r--  1 105  user   10125 Aug  4  1987 RUNHTSM.CSS
-rw-rw-r--  1 105  user   10044 Dec 24  1986 RUNSSMS.CSS
-rw-rw-r--  1 105  user   10044 Sep 18  1987 RUNTEMP3.CSS
-rw-rw-r--  1 105  user    8910 Nov 17  1986 SAFE.FTN
-rw-rw-r--  1 105  user  140940 Oct  6  1986 SIM0.INP
-rw-rw-r--  1 105  user  151065 Jan  6  1987 SIM1.INP
```

-rw-rw-r--	1 105	user	796630	Dec 29	1986	SIM1.OUT
-rw-rw-r--	1 105	user	151065	Dec 29	1986	SIM1ANTM.INP
-rw-rw-r--	1 105	user	3052520	Dec 30	1986	SIM1ANTM.OUT
-rw-rw-r--	1 105	user	77274	Dec 23	1986	SIM1FD.FTN
-rw-rw-r--	1 105	user	140940	Oct 31	1986	SIM2.INP
-rw-rw-r--	1 105	user	567490	Dec 23	1986	SIM2.OUT
-rw-rw-r--	1 105	user	116964	Oct 31	1986	SIM2BFD.FTN
-rw-rw-r--	1 105	user	116964	Oct 31	1986	SIM2FD.FTN
-rw-rw-r--	1 105	user	140940	Oct 6	1986	SIM3.INP
-rw-rw-r--	1 105	user	70389	Oct 6	1986	SIM3FD.FTN
-rw-rw-r--	1 105	user	30537	Oct 2	1986	SIMFD.FTN
-rw-rw-r--	1 105	user	6399	Dec 31	1984	SINFD.FTN
-rw-rw-r--	1 105	user	27297	Sep 3	1986	SINFDA.FTN
-rw-rw-r--	1 105	user	98334	Oct 15	1985	SLED.INP
-rw-rw-r--	1 105	user	160704	Oct 30	1985	SLEDFD.FTN
-rw-rw-r--	1 105	user	15471	Jul 6	1984	SLIDER.FTN
-rw-rw-r--	1 105	user	15552	Jul 6	1984	SLIDERA.FTN
-rw-rw-r--	1 105	user	60183	Jan 13	1987	SPEC1.INP
-rw-rw-r--	1 105	user	165222	Jan 13	1987	SPEC1.OUT
-rw-rw-r--	1 105	user	60183	Jan 13	1987	SPEC2.INP
-rw-rw-r--	1 105	user	1163790	Jan 6	1987	SPEC2.OUT
-rw-rw-r--	1 105	user	60183	Jan 13	1987	SPEC3.INP
-rw-rw-r--	1 105	user	1163790	Jan 8	1987	SPEC3.OUT
-rw-rw-r--	1 105	user	60183	Jan 13	1987	SPEC4.INP
-rw-rw-r--	1 105	user	1163790	Jan 9	1987	SPEC4.OUT
-rw-rw-r--	1 105	user	60183	Jan 5	1987	SPEC5.INP
-rw-rw-r--	1 105	user	164552	Jan 9	1987	SPEC5.OUT
-rw-rw-r--	1 105	user	60183	Jan 5	1987	SPEC6.INP
-rw-rw-r--	1 105	user	12717	Aug 6	1987	SSM.INP
-rw-rw-r--	1 105	user	451848	Aug 6	1987	SSM.OUT
-rw-rw-r--	1 105	user	13689	Aug 6	1987	SSM.PUN
-rw-rw-r--	1 105	user	5751	Apr 18	1985	SSM1DOF.FTN
-rw-rw-r--	1 105	user	5508	May 2	1985	SSM1DOF1.FTN
-rw-rw-r--	1 105	user	1620	May 20	1985	SSM1DOF1.INP
-rw-rw-r--	1 105	user	2106	May 31	1985	SSM2DOF.INP
-rw-rw-r--	1 105	user	2106	Jun 6	1985	SSM2DOFA.INP
-rw-rw-r--	1 105	user	99387	Sep 11	1986	SSMACES.INP
-rw-rw-r--	1 105	user	53865	Aug 4	1987	SSMFD.FTN
-rw-rw-r--	1 105	user	257950	Aug 6	1987	SSMFD.LST
-rw-rw-r--	1 105	user	8181	May 24	1985	SSMGZ4.FTN
-rw-rw-r--	1 105	user	18549	May 16	1985	SSMPLOT.FTN
-rw-rw-r--	1 105	user	5670	Feb 12	1985	SSMSTEP.FTN
-rw-rw-r--	1 105	user	87885	May 15	1986	STANDARD.INP
-rw-rw-r--	1 105	user	10287	Dec 19	1986	STEP.CSS
-rw-rw-r--	1 105	user	43092	Dec 19	1986	STEP.FTN
-rw-rw-r--	1 105	user	147906	Dec 23	1986	STEP.INP
-rw-rw-r--	1 105	user	578344	Dec 23	1986	STEP.OUT
-rw-rw-r--	1 105	user	96309	Jul 12	1985	STRESS.INP
-rw-rw-r--	1 105	user	18468	Aug 20	1986	SUBTN.FTN
-rw-rw-r--	1 105	user	16848	Aug 20	1986	SUBTRACT.FTN
-rw-rw-r--	1 105	user	6834	Aug 20	1986	SUBTRACT.OUT
-rw-rw-r--	1 105	user	1215	Aug 18	1986	SWITCH.FTN
-rw-rw-r--	1 105	user	810	Dec 7	1986	TEMP.FTN
-rw-rw-r--	1 105	user	7533	Feb 28	1986	TENDOF.INP
-rw-rw-r--	1 105	user	230300	May 7	1970	TESTREP.LAC
-rw-rw-r--	1 105	user	2997	Feb 28	1986	THREEDOF.INP

```
-rw-rw-r--   1 105    user   255672 Feb 28  1986 THREEDOF.OUT
-rw-rw-r--   1 105    user     2673 May  9  1985 TRAP.FTN
-rw-rw-r--   1 105    user     2916 Jun 18  1985 TRAPT.FTN
-rw-rw-r--   1 105    user      324 Oct  2  1986 TRIGGER.FTN
-rw-rw-r--   1 105    user     2592 May  9  1985 TRYTRAP.FTN
-rw-rw-r--   1 105    user     2349 Feb 28  1986 TWODOF.INP
-rw-rw-r--   1 105    user   216142 Feb 28  1986 TWODOF.OUT
-rw-rw-r--   1 105    user    77586 Aug 27  1986 VISCO1D.FTN
-rw-rw-r--   1 105    user    35721 Aug 10  1987 WHAM3.FTN
-rw-rw-r--   1 105    user    42120 May 15  1985 WHAMA.FTN
-rw-rw-r--   1 105    user    42444 May 20  1985 WHAMDLT.FTN
-rw-rw-r--   1 105    user    42363 Nov 26  1984 WHAMII.FTN
-rw-rw-r--   1 105    user    42444 Sep 25  1985 WHAMRS2.FTN
-rw-rw-r--   1 105    user    42930 Feb  4  1987 WHAMRSJ.FTN
-rw-rw-r--   1 105    user    42363 Mar 11  1985 WHAMSM.FTN
-rw-rw-r--   1 105    user    42768 Feb 26  1986 WHAMSSM.FTN
-rw-rw-r--   1 root   sys         0 Aug 16 14:18 dir001
```

Archived Files in Directory HSM 002

```
total 2191
drwxr-xr-x   2 105   user   8192 Aug 16 14:19 ./
drwxrwxrwx  17 root  sys    2560 Jul 21 21:46 ../
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL1ACC.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL1VEL.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL3VEL.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL5ACC.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL5VEL.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL7ACC.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL7VEL.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL9ACC.INP
-rw-rw-r--   1 105   user    486 Feb 25  1985 EL9VEL.INP
-rw-rw-r--   1 105   user   3078 Dec 14  1984 FRCRILS.FTN
-rw-rw-r--   1 105   user   3321 Dec  7  1984 FRCRTC.FTN
-rw-rw-r--   1 105   user   3321 Jan 29  1985 FRCRTC20.FTN
-rw-rw-r--   1 105   user   3402 Jan  9  1985 FRCRTC2D.FTN
-rw-rw-r--   1 105   user   3564 Jun 24  1985 FREAS1.FTN
-rw-rw-r--   1 105   user   3564 Jul 10  1985 FREAS10.FTN
-rw-rw-r--   1 105   user   3564 Jul 10  1985 FREAS11.FTN
-rw-rw-r--   1 105   user   3564 Jun 25  1985 FREAS2.FTN
-rw-rw-r--   1 105   user   3564 Jun 26  1985 FREAS2B.FTN
-rw-rw-r--   1 105   user   3564 Jun 25  1985 FREAS3.FTN
-rw-rw-r--   1 105   user   3564 Jun 25  1985 FREAS4.FTN
-rw-rw-r--   1 105   user   3564 Jun 26  1985 FREAS4B.FTN
-rw-rw-r--   1 105   user   3564 Jun 27  1985 FREAS5.FTN
-rw-rw-r--   1 105   user   3564 Jun 28  1985 FREAS6.FTN
-rw-rw-r--   1 105   user   3564 Jul  1  1985 FREAS7.FTN
-rw-rw-r--   1 105   user   3564 Jul  3  1985 FREAS8.FTN
-rw-rw-r--   1 105   user   3564 Jul  3  1985 FREAS9.FTN
-rw-rw-r--   1 105   user   3564 Jul 11  1985 FREASL.FTN
-rw-rw-r--   1 105   user    486 Oct 15  1984 FRFDSIN.FTN
-rw-rw-r--   1 105   user   3564 Jun 21  1985 FRFRC1.FTN
-rw-rw-r--   1 105   user   3564 Jun 21  1985 FRFRC10.FTN
-rw-rw-r--   1 105   user   1539 Nov 27  1984 FRSK2.FTN
-rw-rw-r--   1 105   user   3564 Jun 24  1985 FRSK207.FTN
-rw-rw-r--   1 105   user   3564 Jun 14  1985 FRSK20H.FTN
-rw-rw-r--   1 105   user   3564 Jun 18  1985 FRSK20I.FTN
-rw-rw-r--   1 105   user   3564 Jun 18  1985 FRSK20J.FTN
-rw-rw-r--   1 105   user   3564 Jun 20  1985 FRSK20K.FTN
-rw-rw-r--   1 105   user   4617 Jun 24  1985 FRSK20L.FTN
-rw-rw-r--   1 105   user   4617 Jun 21  1985 FRSK20M.FTN
-rw-rw-r--   1 105   user   3564 Jun  4  1985 FRSK23.FTN
-rw-rw-r--   1 105   user   3564 Jun 21  1985 FRSK236.FTN
-rw-rw-r--   1 105   user   3564 Jun 21  1985 FRSK237.FTN
-rw-rw-r--   1 105   user   3564 Jun 21  1985 FRSK238.FTN
-rw-rw-r--   1 105   user   3564 Jun  5  1985 FRSK23B.FTN
-rw-rw-r--   1 105   user   3564 Jun  6  1985 FRSK23C.FTN
-rw-rw-r--   1 105   user   3564 Jun 11  1985 FRSK23D.FTN
-rw-rw-r--   1 105   user   3564 Jun 11  1985 FRSK23E.FTN
-rw-rw-r--   1 105   user   3564 Jun 12  1985 FRSK23F.FTN
-rw-rw-r--   1 105   user   3564 Jun 14  1985 FRSK23H.FTN
-rw-rw-r--   1 105   user   3564 Jun  4  1985 FRSK24.FTN
-rw-rw-r--   1 105   user   3564 Jun 12  1985 FRSK24F.FTN
-rw-rw-r--   1 105   user   3564 Jun 13  1985 FRSK24G.FTN
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-rw-rw-r--  1 105   user   3564 Jun  4  1985 FRSK25.FTN
-rw-rw-r--  1 105   user   3564 Jun 21  1985 FRSK256.FTN
-rw-rw-r--  1 105   user   3564 Jun 21  1985 FRSK257.FTN
-rw-rw-r--  1 105   user   3564 Jun 21  1985 FRSK258.FTN
-rw-rw-r--  1 105   user   3564 Jun 14  1985 FRSK25H.FTN
-rw-rw-r--  1 105   user   3564 Jun  4  1985 FRSK26.FTN
-rw-rw-r--  1 105   user   3564 Jun 21  1985 FRSK267.FTN
-rw-rw-r--  1 105   user   3564 Jun 12  1985 FRSK26F.FTN
-rw-rw-r--  1 105   user   3564 Jun 14  1985 FRSK27H.FTN
-rw-rw-r--  1 105   user   3564 Jun 12  1985 FRSK28F.FTN
-rw-rw-r--  1 105   user   3078 Jan  9  1985 FRSK2A.FTN
-rw-rw-r--  1 105   user   3078 Jan 23  1985 FRSK2B.FTN
-rw-rw-r--  1 105   user   3078 May  1  1985 FRSK2C.FTN
-rw-rw-r--  1 105   user   3564 Jun  4  1985 FRSK30.FTN
-rw-rw-r--  1 105   user   3564 Jun 12  1985 FRSK30F.FTN
-rw-rw-r--  1 105   user   3564 Jun 14  1985 FRSK30H.FTN
-rw-rw-r--  1 105   user   3078 Jun  5  1985 FRSKFRC.FTN
-rw-rw-r--  1 105   user   3483 Jun 14  1985 FRSKFRC1.FTN
-rw-rw-r--  1 105   user   3483 Jun 14  1985 FRSKFRC2.FTN
-rw-rw-r--  1 105   user   4617 Jun 20  1985 FRSKFRC3.001
-rw-rw-r--  1 105   user   4617 Jun 21  1985 FRSKFRC3.FTN
-rw-rw-r--  1 105   user   4617 Jun 21  1985 FRSKFRC4.FTN
-rw-rw-r--  1 105   user   3078 Jun  6  1985 FRSKFRCB.FTN
-rw-rw-r--  1 105   user   4131 May 24  1985 HCS1ASA.INP
-rw-rw-r--  1 105   user    486 May 28  1985 HCS1ASA.PUN
-rw-rw-r--  1 105   user   4131 May 20  1985 HCS1CGA.INP
-rw-rw-r--  1 105   user    486 May 21  1985 HCS1CGA.PUN
-rw-rw-r--  1 105   user   4131 May 20  1985 HCS1CGP.INP
-rw-rw-r--  1 105   user    486 May 21  1985 HCS1CGP.PUN
-rw-rw-r--  1 105   user    486 May 24  1985 HCS20G40.FTN
-rw-rw-r--  1 105   user   4131 Jun  3  1985 HCS2CGA.INP
-rw-rw-r--  1 105   user   4131 May 21  1985 HCS2CGP.INP
-rw-rw-r--  1 105   user    486 May 23  1985 HCS2CGP.PUN
-rw-rw-r--  1 105   user   4131 May 19  1985 HCS3CGA.INP
-rw-rw-r--  1 105   user    486 May 21  1985 HCS3CGA.PUN
-rw-rw-r--  1 105   user   4131 May 21  1985 HCS3CGP.INP
-rw-rw-r--  1 105   user    486 May 24  1985 HCS3CGP.PUN
-rw-rw-r--  1 105   user   2025 Jul  1  1985 HCS685.FTN
-rw-rw-r--  1 105   user   4131 Sep 25  1985 HCS685A1.INP
-rw-rw-r--  1 105   user    486 Sep 26  1985 HCS685A1.PUN
-rw-rw-r--  1 105   user    972 Sep 28  1985 HCS685A2.PUN
-rw-rw-r--  1 105   user    972 Oct  1  1985 HCS685A3.PUN
-rw-rw-r--  1 105   user    486 Oct 11  1985 HCS685A4.PUN
-rw-rw-r--  1 105   user    486 Oct  3  1985 HCS685A5.PUN
-rw-rw-r--  1 105   user    486 Oct 11  1985 HCS685R1.INP
-rw-rw-r--  1 105   user    486 Oct 12  1985 HCS685R1.PUN
-rw-rw-r--  1 105   user    486 Oct 11  1985 HCS685R2.INP
-rw-rw-r--  1 105   user    486 Oct 13  1985 HCS685R2.PUN
-rw-rw-r--  1 105   user   4131 Mar 22  1985 HCSGZ1KA.INP
-rw-rw-r--  1 105   user    486 Mar 22  1985 HCSGZ1KA.PUN
-rw-rw-r--  1 105   user    486 Mar 26  1985 HCSGZ1KB.PUN
-rw-rw-r--  1 105   user   4131 Apr  4  1985 HCSGZ1KG.INP
-rw-rw-r--  1 105   user    486 Mar 28  1985 HCSGZ1KG.PUN
-rw-rw-r--  1 105   user   4131 Apr  1  1985 HCSGZ1KH.INP
-rw-rw-r--  1 105   user    486 Apr  2  1985 HCSGZ1KH.PUN
-rw-rw-r--  1 105   user   4050 Jan 28  1985 HCSGZ1SP.INP
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-rw-rw-r--   1 105    user     4131 Mar  8  1985 HCSGZ2KB.INP
-rw-rw-r--   1 105    user      486 Mar 15  1985 HCSGZ2KB.PUN
-rw-rw-r--   1 105    user     4131 Mar 11  1985 HCSGZ2KC.INP
-rw-rw-r--   1 105    user      486 Mar 15  1985 HCSGZ2KC.PUN
-rw-rw-r--   1 105    user     4131 Mar 13  1985 HCSGZ2KD.INP
-rw-rw-r--   1 105    user      486 Mar 18  1985 HCSGZ2KD.PUN
-rw-rw-r--   1 105    user     4131 Mar 14  1985 HCSGZ2KE.INP
-rw-rw-r--   1 105    user      486 Mar 18  1985 HCSGZ2KE.PUN
-rw-rw-r--   1 105    user     4131 Mar 15  1985 HCSGZ2KF.INP
-rw-rw-r--   1 105    user      486 Mar 20  1985 HCSGZ2KF.PUN
-rw-rw-r--   1 105    user     4131 Mar 22  1985 HCSGZ2KG.INP
-rw-rw-r--   1 105    user      486 Mar 25  1985 HCSGZ2KG.PUN
-rw-rw-r--   1 105    user     4050 Dec 13  1984 HCSGZ2SP.INP
-rw-rw-r--   1 105    user     4131 Mar 22  1985 HCSGZ3KA.INP
-rw-rw-r--   1 105    user      486 Mar 26  1985 HCSGZ3KA.PUN
-rw-rw-r--   1 105    user     4131 Jan 18  1985 HCSGZ3SP.INP
-rw-rw-r--   1 105    user     4131 Mar  6  1985 HCSGZ42K.INP
-rw-rw-r--   1 105    user      486 May 21  1985 HCSGZ42K.PUN
-rw-rw-r--   1 105    user     4131 Apr 29  1985 HCSGZ4R.FTN
-rw-rw-r--   1 105    user     4131 May 24  1985 HCSGZ4SP.INP
-rw-rw-r--   1 105    user      486 May 28  1985 HCSGZ4SP.PUN
-rw-rw-r--   1 105    user     4131 May 24  1985 HCSGZ5SP.INP
-rw-rw-r--   1 105    user      486 May 17  1985 HCSGZ5SP.PUN
-rw-rw-r--   1 105    user      486 May 13  1985 HCSMCC.PUN
-rw-rw-r--   1 105    user    20736 Mar 11  1985 HCSMREF.FTN
-rw-rw-r--   1 105    user    20736 May  7  1985 HCSMRST.FTN
-rw-rw-r--   1 105    user    21222 May  7  1985 HCSMRSTO.FTN
-rw-rw-r--   1 105    user      486 Apr  8  1985 HCSRSTA1.PUN
-rw-rw-r--   1 105    user      486 Apr  8  1985 HCSRSTA2.PUN
-rw-rw-r--   1 105    user      486 Apr  8  1985 HCSRSTB1.PUN
-rw-rw-r--   1 105    user      972 Apr  8  1985 HCSRSTB2.PUN
-rw-rw-r--   1 105    user      486 Jun 12  1985 HCSSTA1R.PUN
-rw-rw-r--   1 105    user      486 Jun 12  1985 HCSSTA2R.PUN
-rw-rw-r--   1 105    user      162 Jul 29  1985 HCSSTA3R.INP
-rw-rw-r--   1 105    user      486 Jul 30  1985 HCSSTA3R.PUN
-rw-rw-r--   1 105    user     4131 Jun  3  1985 HCSSTDA.INP
-rw-rw-r--   1 105    user      486 Jun  3  1985 HCSSTDA.PUN
-rw-rw-r--   1 105    user     4131 Jun  4  1985 HCSSTDA1.INP
-rw-rw-r--   1 105    user      486 Jun 12  1985 HCSSTDA1.PUN
-rw-rw-r--   1 105    user     4131 Jun  7  1985 HCSSTDA2.INP
-rw-rw-r--   1 105    user      486 Jun 12  1985 HCSSTDA2.PUN
-rw-rw-r--   1 105    user     2592 Jul 26  1985 HCSSTDA3.FTN
-rw-rw-r--   1 105    user     4131 Jul 26  1985 HCSSTDA3.INP
-rw-rw-r--   1 105    user      486 Jul 29  1985 HCSSTDA3.PUN
-rw-rw-r--   1 105    user     4131 Jun 18  1985 HCSTEST.INP
-rw-rw-r--   1 105    user      486 Jun 19  1985 HCSTEST.PUN
-rw-rw-r--   1 105    user     4131 Jun 14  1985 HCSTEST1.INP
-rw-rw-r--   1 105    user      486 Jun 16  1985 HCSTEST1.PUN
-rw-rw-r--   1 105    user      243 Jun 19  1985 HCSTESTR.INP
-rw-rw-r--   1 105    user      486 Jun 19  1985 HCSTESTR.PUN
-rw-rw-r--   1 105    user      486 Jun 19  1985 HCSTSTR2.INP
-rw-rw-r--   1 105    user      486 Jun 25  1985 HCSTSTR2.PUN
-rw-rw-r--   1 105    user     2025 Jan 17  1985 HS3SK1B.INP
-rw-rw-r--   1 105    user     2025 Apr 26  1985 HS3SK1C.INP
-rw-rw-r--   1 105    user     2025 Jan 21  1985 HS3SK3B.INP
-rw-rw-r--   1 105    user     2025 Jan 23  1985 HS3SK5B.INP
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-rw-rw-r--  1 105  user   2025 Apr 29  1985 HS3SK5C.INP
-rw-rw-r--  1 105  user   2025 Jan 22  1985 HS3SK7B.INP
-rw-rw-r--  1 105  user   2025 Apr 29  1985 HS3SK7C.INP
-rw-rw-r--  1 105  user    486 Mar 12  1985 JADJUST.FTN
-rw-rw-r--  1 105  user   1539 Mar 12  1985 JBABALPH.FTN
-rw-rw-r--  1 105  user    486 Mar 12  1985 JBABFREE.FTN
-rw-rw-r--  1 105  user   1539 Mar 12  1985 JBABOON.DTA
-rw-rw-r--  1 105  user    486 Mar 12  1985 JBOONTST.CSS
-rw-rw-r--  1 105  user   9581 Mar 12  1985 JC.
-rw-rw-r--  1 105  user    505 Mar 12  1985 JCODETST.CSS
-rw-rw-r--  1 105  user    324 Mar 12  1985 JDOFTEST.DTA
-rw-rw-r--  1 105  user    486 Mar 12  1985 JDOFTEST.FTN
-rw-rw-r--  1 105  user    486 Mar 12  1985 JDRECTRY.
-rw-rw-r--  1 105  user    486 Mar 12  1985 KFLEX1.AIN
-rw-rw-r--  1 105  user    486 Mar 12  1985 KFLEX2.AIN
-rw-rw-r--  1 105  user   1539 Mar 12  1985 KHS.FTN
-rw-rw-r--  1 105  user    486 Mar 12  1985 KHS1.INP
-rw-rw-r--  1 105  user    486 Mar 12  1985 KHS2.INP
-rw-rw-r--  1 105  user    486 Mar 12  1985 KHS3.INP
-rw-rw-r--  1 105  user    486 Mar 12  1985 KHS4.INP
-rw-rw-r--  1 105  user    402 Mar 12  1985 KLIST.COU
-rw-rw-r--  1 105  user    402 Mar 12  1985 KOUTPUT.1
-rw-rw-r--  1 105  user  13400 Mar 12  1985 KOUTPUT.AOU
-rw-rw-r--  1 105  user    486 Mar 12  1985 KVIEW.VIN
-rw-rw-r--  1 105  user   1974 Mar 12  1985 KVIEW.VPL
-rw-rw-r--  1 105  user   2592 Mar 26  1985 LDEL0.INP
-rw-rw-r--  1 105  user    486 Mar 27  1985 LDEL0.PUN
-rw-rw-r--  1 105  user   2592 Mar 26  1985 LDEL0R.INP
-rw-rw-r--  1 105  user    486 Mar 27  1985 LDEL0R.PUN
-rw-rw-r--  1 105  user    972 Mar 26  1985 LDEL0ROT.INP
-rw-rw-r--  1 105  user   2592 Mar 27  1985 LDEL10.INP
-rw-rw-r--  1 105  user    486 Mar 28  1985 LDEL10.PUN
-rw-rw-r--  1 105  user   2592 Mar 27  1985 LDEL15.INP
-rw-rw-r--  1 105  user    486 Mar 28  1985 LDEL15.PUN
-rw-rw-r--  1 105  user   2592 Mar 27  1985 LDEL20.INP
-rw-rw-r--  1 105  user    486 Mar 28  1985 LDEL20.PUN
-rw-rw-r--  1 105  user    486 Mar 23  1985 LDEL20A.PUN
-rw-rw-r--  1 105  user    486 Mar 23  1985 LDEL20B.PUN
-rw-rw-r--  1 105  user   2592 Mar 27  1985 LDEL5.INP
-rw-rw-r--  1 105  user    486 Mar 28  1985 LDEL5.PUN
-rw-rw-r--  1 105  user   2592 Oct 23  1985 ORGCS4.INP
-rw-rw-r--  1 105  user    486 Oct 24  1985 ORGCS4.PUN
-rw-rw-r--  1 105  user   2592 Oct 23  1985 ORGCS6.INP
-rw-rw-r--  1 105  user    486 Oct 24  1985 ORGCS6.PUN
-rw-rw-r--  1 105  user   2592 Oct 23  1985 ORGCS8.INP
-rw-rw-r--  1 105  user    486 Oct 24  1985 ORGCS8.PUN
-rw-rw-r--  1 105  user   2592 Oct 17  1985 ORGCSC.INP
-rw-rw-r--  1 105  user    486 Oct 18  1985 ORGCSC.PUN
-rw-rw-r--  1 105  user   2592 Jun 14  1985 SK20G50B.INP
-rw-rw-r--  1 105  user   2592 Jun 19  1985 SK20G50C.INP
-rw-rw-r--  1 105  user   2592 Jun 21  1985 SK20G50D.INP
-rw-rw-r--  1 105  user   2592 Jun  4  1985 SK23G50.INP
-rw-rw-r--  1 105  user   2592 Jun 21  1985 SK23G506.INP
-rw-rw-r--  1 105  user   2592 Jun 21  1985 SK23G507.INP
-rw-rw-r--  1 105  user   2592 Jun 21  1985 SK23G508.INP
-rw-rw-r--  1 105  user   2592 Jun  5  1985 SK23G50B.INP
```

```
-rw-rw-r--  1 105  user  2592 Jun  4  1985 SK24G50.INP
-rw-rw-r--  1 105  user  2592 Jun 12  1985 SK24G50B.INP
-rw-rw-r--  1 105  user  2592 Jun 13  1985 SK24G50C.INP
-rw-rw-r--  1 105  user  2592 Jun  4  1985 SK25G50.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SK25G506.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SK25G507.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SK25G508.INP
-rw-rw-r--  1 105  user  2592 Jun 14  1985 SK25G50B.INP
-rw-rw-r--  1 105  user  2592 Jun  4  1985 SK26G50.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SK26G507.INP
-rw-rw-r--  1 105  user  2592 Jun 12  1985 SK26G50B.INP
-rw-rw-r--  1 105  user  2592 Jun 14  1985 SK27G50B.INP
-rw-rw-r--  1 105  user  2592 Jun  3  1985 SK28G50.INP
-rw-rw-r--  1 105  user  2592 Jun 12  1985 SK28G50B.INP
-rw-rw-r--  1 105  user  2592 May 31  1985 SK30G50.INP
-rw-rw-r--  1 105  user  2592 Jun 14  1985 SK30G50B.INP
-rw-rw-r--  1 105  user  2592 Jun 24  1985 SKEAS1.INP
-rw-rw-r--  1 105  user  2592 Jul 10  1985 SKEAS10.INP
-rw-rw-r--  1 105  user   486 Jul 10  1985 SKEAS10.PUN
-rw-rw-r--  1 105  user  2592 Jul 10  1985 SKEAS11.INP
-rw-rw-r--  1 105  user   486 Jul 10  1985 SKEAS11.PUN
-rw-rw-r--  1 105  user  2592 Aug 13  1985 SKEAS13.INP
-rw-rw-r--  1 105  user  2592 Aug 13  1985 SKEAS15.INP
-rw-rw-r--  1 105  user  2592 Aug 13  1985 SKEAS17.INP
-rw-rw-r--  1 105  user   486 Oct 17  1985 SKEAS17.PUN
-rw-rw-r--  1 105  user  2592 Jun 25  1985 SKEAS2.INP
-rw-rw-r--  1 105  user   486 Jun 25  1985 SKEAS2.PUN
-rw-rw-r--  1 105  user  2592 Jun 26  1985 SKEAS2B.INP
-rw-rw-r--  1 105  user   486 Jun 26  1985 SKEAS2B.PUN
-rw-rw-r--  1 105  user  2592 Jun 25  1985 SKEAS3.INP
-rw-rw-r--  1 105  user   486 Jun 26  1985 SKEAS3.PUN
-rw-rw-r--  1 105  user  2592 Jun 26  1985 SKEAS4.INP
-rw-rw-r--  1 105  user   486 Jun 26  1985 SKEAS4.PUN
-rw-rw-r--  1 105  user  2592 Jun 26  1985 SKEAS4B.INP
-rw-rw-r--  1 105  user   486 Jun 26  1985 SKEAS4B.PUN
-rw-rw-r--  1 105  user  2592 Jun 27  1985 SKEAS5.INP
-rw-rw-r--  1 105  user   486 Jun 27  1985 SKEAS5.PUN
-rw-rw-r--  1 105  user  2592 Jun 28  1985 SKEAS6.INP
-rw-rw-r--  1 105  user   486 Jun 28  1985 SKEAS6.PUN
-rw-rw-r--  1 105  user  2592 Jul  1  1985 SKEAS7.INP
-rw-rw-r--  1 105  user   486 Jul  1  1985 SKEAS7.PUN
-rw-rw-r--  1 105  user  2592 Jul  2  1985 SKEAS8.INP
-rw-rw-r--  1 105  user   486 Jul  3  1985 SKEAS8.PUN
-rw-rw-r--  1 105  user  2592 Jul  2  1985 SKEAS9.INP
-rw-rw-r--  1 105  user   486 Jul  4  1985 SKEAS9.PUN
-rw-rw-r--  1 105  user  2592 Jul 11  1985 SKEASL.INP
-rw-rw-r--  1 105  user   486 Jul 11  1985 SKEASL.PUN
-rw-rw-r--  1 105  user  2592 Jul 15  1985 SKEASL2.INP
-rw-rw-r--  1 105  user  2592 Jul 16  1985 SKEASL3.INP
-rw-rw-r--  1 105  user  2592 Jul 16  1985 SKEASL4.INP
-rw-rw-r--  1 105  user  2592 Jun  5  1985 SKFRC.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SKFRC1.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SKFRC10.INP
-rw-rw-r--  1 105  user  2592 Jun 14  1985 SKFRC2.INP
-rw-rw-r--  1 105  user  2592 Jun 20  1985 SKFRC3.INP
-rw-rw-r--  1 105  user  2592 Jun 21  1985 SKFRC4.INP
```

```
-rw-rw-r--  1 105  user   3078 Feb  5  1985 SLIDACC.FTN
-rw-rw-r--  1 105  user   3078 Feb  5  1985 SLIDVEL.FTN
-rw-rw-r--  1 105  user    972 Dec  5  1984 SSMGZ250.INP
-rw-rw-r--  1 105  user    972 Dec 10  1984 SSMGZ350.INP
-rw-rw-r--  1 105  user   2592 Jan  2  1985 TC340B.INP
-rw-rw-r--  1 105  user   2592 Mar 19  1985 TC35.INP
-rw-rw-r--  1 105  user   2592 Mar 19  1985 TC40.INP
-rw-rw-r--  1 105  user   2592 Feb  8  1985 TC550B.INP
-rw-rw-r--  1 105  user   2592 Jan  2  1985 TC650B.INP
-rw-rw-r--  1 105  user   2592 Jan  2  1985 TC750B.INP
-rw-rw-r--  1 105  user    486 Nov 15  1984 TDHCSGY1.FTN
-rw-rw-r--  1 105  user   4131 Nov 15  1984 TDHCSGY1.INP
-rw-rw-r--  1 105  user    486 Nov 26  1984 TDHCSGY2.FTN
-rw-rw-r--  1 105  user   4131 Nov 26  1984 TDHCSGY2.INP
-rw-rw-r--  1 105  user    486 Nov 15  1984 TDHCSGYM.FTN
-rw-rw-r--  1 105  user    486 Nov 21  1984 TDHCSGZ1.FTN
-rw-rw-r--  1 105  user   3807 Nov 23  1984 TDHCSGZ1.INP
-rw-rw-r--  1 105  user    486 Nov 21  1984 TDHCSGZ2.FTN
-rw-rw-r--  1 105  user   3807 Nov 21  1984 TDHCSGZ2.INP
-rw-rw-r--  1 105  user    486 Apr 29  1985 TDHCSGZ4.FTN
-rw-rw-r--  1 105  user    762 May 13  1985 TDHCSGZ4.LST
-rw-rw-r--  1 105  user    486 Apr 18  1985 TDSSMGZ1.FTN
-rw-rw-r--  1 105  user    486 Oct 19  1984 TDSSMGZ1.INP
-rw-rw-r--  1 105  user    486 Oct 24  1984 TDSSMGZ2.FTN
-rw-rw-r--  1 105  user    972 Nov 20  1984 TDSSMGZ2.INP
-rw-rw-r--  1 105  user    972 Dec 10  1984 TDSSMGZ3.FTN
-rw-rw-r--  1 105  user    486 Mar 19  1985 TDSSMGZ4.FTN
-rw-rw-r--  1 105  user    972 Mar  5  1985 TDSSMGZ4.INP
-rw-rw-r--  1 105  user   2592 Jun 14  1985 TEST1.FTN
-rw-rw-r--  1 105  user   4131 Jun 14  1985 TEST1.INP
-rw-rw-r--  1 105  user    486 Jun 18  1985 TEST1.PUN
-rw-rw-r--  1 105  user   4131 Jun 28  1985 TEST12CG.INP
-rw-rw-r--  1 105  user    486 Jul  2  1985 TEST12CG.PUN
-rw-rw-r--  1 105  user    162 Jun 17  1985 TEST1R.INP
-rw-rw-r--  1 105  user    486 Jun 18  1985 TEST1R.PUN
-rw-rw-r--  1 105  user   2592 Jun 18  1985 TEST2.FTN
-rw-rw-r--  1 105  user   4131 Jun 14  1985 TEST2.INP
-rw-rw-r--  1 105  user    486 Jun 19  1985 TEST2.PUN
-rw-rw-r--  1 105  user    162 Jun 17  1985 TEST2R.INP
-rw-rw-r--  1 105  user    486 Jun 18  1985 TEST2R.PUN
-rw-rw-r--  1 105  user   2592 Jun 19  1985 TEST3.FTN
-rw-rw-r--  1 105  user   4131 Jun 21  1985 TEST3.INP
-rw-rw-r--  1 105  user    486 Jun 23  1985 TEST3.PUN
-rw-rw-r--  1 105  user    162 Jun 21  1985 TEST3R.INP
-rw-rw-r--  1 105  user    486 Jun 23  1985 TEST3R.PUN
-rw-rw-r--  1 105  user   2592 Jun 27  1985 TEST4.FTN
-rw-rw-r--  1 105  user   4131 Jun 27  1985 TEST4.INP
-rw-rw-r--  1 105  user    486 Jul  2  1985 TEST4.PUN
-rw-rw-r--  1 105  user   4131 Jun 28  1985 TEST42CG.INP
-rw-rw-r--  1 105  user    486 Jul  2  1985 TEST42CG.PUN
-rw-rw-r--  1 105  user    162 Jun 27  1985 TEST4R.INP
-rw-rw-r--  1 105  user    486 Jul  2  1985 TEST4R.PUN
-rw-rw-r--  1 105  user   2025 Mar 29  1985 WHAMA.FTN
-rw-rw-r--  1 105  user   2025 Apr 18  1985 WHAMASM.FTN
-rw-rw-r--  1 105  user   2025 May  7  1985 WHAMRST.FTN
-rw-rw-r--  1 105  user  20736 May 13  1985 XALMOST.FTN
```

```
-rw-rw-r--  1 105  user  20736 May 13  1985 XALMOSTC.FTN
-rw-rw-r--  1 105  user  20736 May 13  1985 XALMOSTS.FTN
-rw-rw-r--  1 105  user    486 May 13  1985 XHCSGY1.FTN
-rw-rw-r--  1 105  user   4131 May 13  1985 XHCSGY1.INP
-rw-rw-r--  1 105  user    486 May 13  1985 XHCSGY2.FTN
-rw-rw-r--  1 105  user   4131 May 13  1985 XHCSGY2.INP
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZ11DEG.DTA
-rw-rw-r--  1 105  user   1474 Jul 29  1985 YZ5DEG.DTA
-rw-rw-r--  1 105  user   2592 Jul 30  1985 YZ5DEG.INP
-rw-rw-r--  1 105  user   1474 Jul 29  1985 YZ6DEG.DTA
-rw-rw-r--  1 105  user   2592 Jul 29  1985 YZ6DEG.INP
-rw-rw-r--  1 105  user   1474 Jul 29  1985 YZ7DEG.DTA
-rw-rw-r--  1 105  user   2592 Jul 30  1985 YZ7DEG.INP
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZAS11DE.DTA
-rw-rw-r--  1 105  user    402 Jul 30  1985 YZAS5DEG.DTA
-rw-rw-r--  1 105  user    402 Jul 30  1985 YZAS6DEG.DTA
-rw-rw-r--  1 105  user    402 Jul 30  1985 YZAS7DEG.DTA
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZASL1.DTA
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZASL2.DTA
-rw-rw-r--  1 105  user    486 Jul 30  1985 YZASORG.DTA
-rw-rw-r--  1 105  user    486 Aug 12  1985 YZASROT.FTN
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZAST10.DTA
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZAST11.DTA
-rw-rw-r--  1 105  user    402 Aug  8  1985 YZAST12.DTA
-rw-rw-r--  1 105  user    402 Aug 12  1985 YZAST7.DTA
-rw-rw-r--  1 105  user    402 Aug  9  1985 YZAST8.DTA
-rw-rw-r--  1 105  user    402 Aug  9  1985 YZAST9.DTA
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZL1.DTA
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZL2.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZL2C.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZL2CF.DTA
-rw-rw-r--  1 105  user    402 Aug 19  1985 YZL3B.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZL3C.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZL3CF.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZL3CFF.DTA
-rw-rw-r--  1 105  user    972 Aug 26  1985 YZL4.DTA
-rw-rw-r--  1 105  user   1474 Aug 26  1985 YZL4CF.DTA
-rw-rw-r--  1 105  user    972 Jul 30  1985 YZORG.DTA
-rw-rw-r--  1 105  user    486 Sep  3  1985 YZROTATE.FTN
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZT10.DTA
-rw-rw-r--  1 105  user   1474 Aug 27  1985 YZT10C.DTA
-rw-rw-r--  1 105  user   1474 Aug 27  1985 YZT10CF.DTA
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZT11.DTA
-rw-rw-r--  1 105  user   1474 Aug 27  1985 YZT11C.DTA
-rw-rw-r--  1 105  user   1474 Aug 27  1985 YZT11CF.DTA
-rw-rw-r--  1 105  user   1474 Aug  8  1985 YZT12.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZT12C.DTA
-rw-rw-r--  1 105  user   1474 Sep  3  1985 YZT12CF.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT1C.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT1CF.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT2C.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT2CF.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT3C.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT3CF.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT5C.DTA
-rw-rw-r--  1 105  user   1474 Aug 29  1985 YZT5CF.DTA
```

-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT6C.DTA
-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT6CF.DTA
-rw-rw-r--	1 105	user	1474	Aug 12	1985	YZT7.DTA
-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT7C.DTA
-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT7CF.DTA
-rw-rw-r--	1 105	user	1474	Aug 9	1985	YZT8.DTA
-rw-rw-r--	1 105	user	402	Aug 19	1985	YZT8B.DTA
-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT8C.DTA
-rw-rw-r--	1 105	user	1474	Aug 28	1985	YZT8CF.DTA
-rw-rw-r--	1 105	user	1474	Aug 8	1985	YZT9.DTA
-rw-rw-r--	1 105	user	3564	Sep 17	1985	Z.FTN
-rw-rw-r--	1 105	user	2592	Sep 10	1985	Z1.INP
-rw-rw-r--	1 105	user	486	Sep 11	1985	Z1.PUN
-rw-rw-r--	1 105	user	2592	Oct 23	1985	Z1CS5.INP
-rw-rw-r--	1 105	user	486	Oct 28	1985	Z1CS5.PUN
-rw-rw-r--	1 105	user	2592	Oct 23	1985	Z1CS7.INP
-rw-rw-r--	1 105	user	486	Oct 28	1985	Z1CS7.PUN
-rw-rw-r--	1 105	user	2592	Oct 23	1985	Z1CS9.INP
-rw-rw-r--	1 105	user	486	Oct 29	1985	Z1CS9.PUN
-rw-rw-r--	1 105	user	2592	Oct 17	1985	Z1CSC.INP
-rw-rw-r--	1 105	user	486	Oct 22	1985	Z1CSC.PUN
-rw-rw-r--	1 105	user	2592	Sep 11	1985	Z2.INP
-rw-rw-r--	1 105	user	486	Sep 12	1985	Z2.PUN
-rw-rw-r--	1 105	user	2592	Sep 17	1985	Z3.INP
-rw-rw-r--	1 105	user	1539	Sep 18	1985	Z3.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3CSA.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3CSA.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3CSB.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3CSB.PUN
-rw-rw-r--	1 105	user	2592	Oct 10	1985	Z3CSBN1.INP
-rw-rw-r--	1 105	user	972	Oct 11	1985	Z3CSBN1.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3CSC.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3CSC.PUN
-rw-rw-r--	1 105	user	2592	Oct 16	1985	Z3CSC2.INP
-rw-rw-r--	1 105	user	972	Oct 23	1985	Z3CSC2.PUN
-rw-rw-r--	1 105	user	2592	Oct 11	1985	Z3CSCN1.INP
-rw-rw-r--	1 105	user	972	Oct 15	1985	Z3CSCN1.PUN
-rw-rw-r--	1 105	user	2592	Oct 10	1985	Z3CSCN2.INP
-rw-rw-r--	1 105	user	2592	Oct 8	1985	Z3CSCN3.INP
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3CSD.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3CSD.PUN
-rw-rw-r--	1 105	user	2592	Oct 9	1985	Z3CSE.INP
-rw-rw-r--	1 105	user	972	Oct 11	1985	Z3CSE.PUN
-rw-rw-r--	1 105	user	486	Oct 11	1985	Z3CSET.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3RH1.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3RH1.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3RH3.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3RH3.PUN
-rw-rw-r--	1 105	user	2592	Oct 4	1985	Z3RH5.INP
-rw-rw-r--	1 105	user	1539	Oct 7	1985	Z3RH5.PUN
-rw-rw-r--	1 105	user	2592	Nov 1	1985	Z3SB1.INP
-rw-rw-r--	1 105	user	1539	Nov 4	1985	Z3SB1.PUN
-rw-rw-r--	1 105	user	2592	Nov 1	1985	Z3SB2.INP
-rw-rw-r--	1 105	user	1539	Nov 4	1985	Z3SB2.PUN
-rw-rw-r--	1 105	user	486	Oct 15	1985	Z3T.PUN
-rw-rw-r--	1 105	user	486	Oct 15	1985	Z3T2.PUN

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-rw-rw-r--   1 105    user     2592 Nov  5  1985 Z4.INP
-rw-rw-r--   1 105    user     1539 Nov  6  1985 Z4.PUN
-rw-rw-r--   1 105    user     2592 Jan  6  1986 ZAT1.INP
-rw-rw-r--   1 105    user     1539 Jan  7  1986 ZAT1.PUN
-rw-rw-r--   1 105    user     3564 Oct  4  1985 ZCS.FTN
-rw-rw-r--   1 105    user     3564 Oct 16  1985 ZCS2.FTN
-rw-rw-r--   1 105    user     3564 Nov  1  1985 ZSB2.FTN
-rw-rw-r--   1 root   sys         0 Aug 16 14:19 dir002
```

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